Outline

Section 1 - MerCruiser PDI and Maintenance - Level 1

- A - Use of Service Literature
- B - Engine Installation and Alignment
- C - Stern Drive Installation
- D - Power Steering Installation
- E - Throttle Cable Adjustment
- F - Pre-delivery Preparation
- G - Winterization and Recommissioning

Section 2 - MerCruiser Electrical Systems - Level 1

- A - Batteries / Wiring
- B - Starting System
- C - Charging System
- D - Ignition Systems
- E - Ignition Secondary
- F - Power Trim Electrical
- G - Quicksilver DMT 2000 Digital Tachometer/Multimeter Information

Section 3 - MerCruiser Fuel Systems - Level 1

- A - Fuel Delivery System and Carburetion
- B - Electronic Fuel Injection - Introduction

Section 4 - Service Information

MerCrusier Applicable Service Bulletin List

MERCRUISER
PDI AND MAINTENANCE
– LEVEL I

1
A

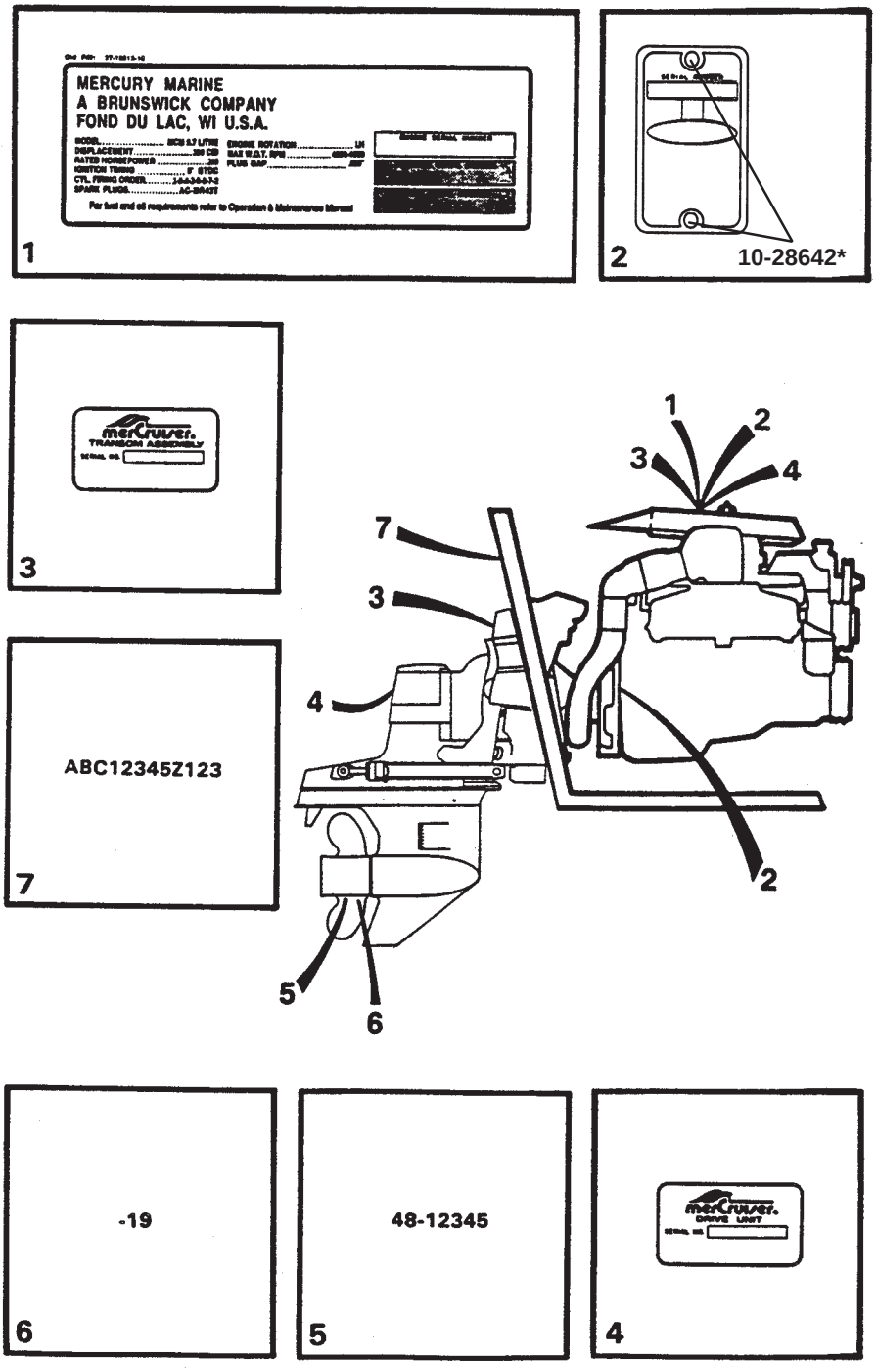
USE OF SERVICE LITERATURE

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Product Identification

MerCruiser Sterndrive - Gas Typical Serial Number Locations

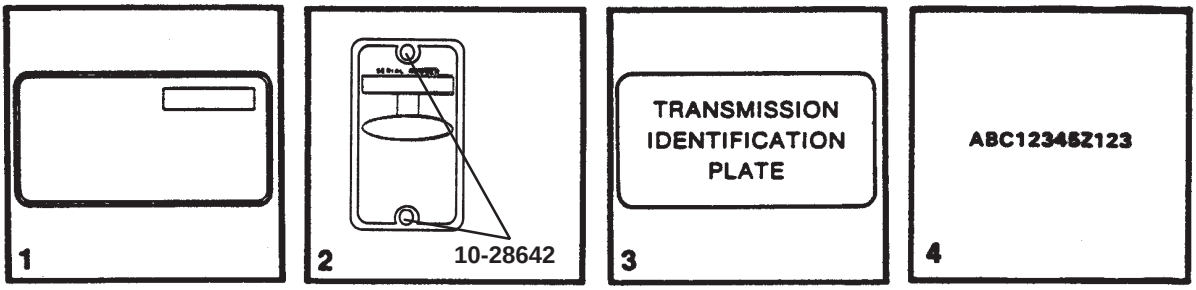


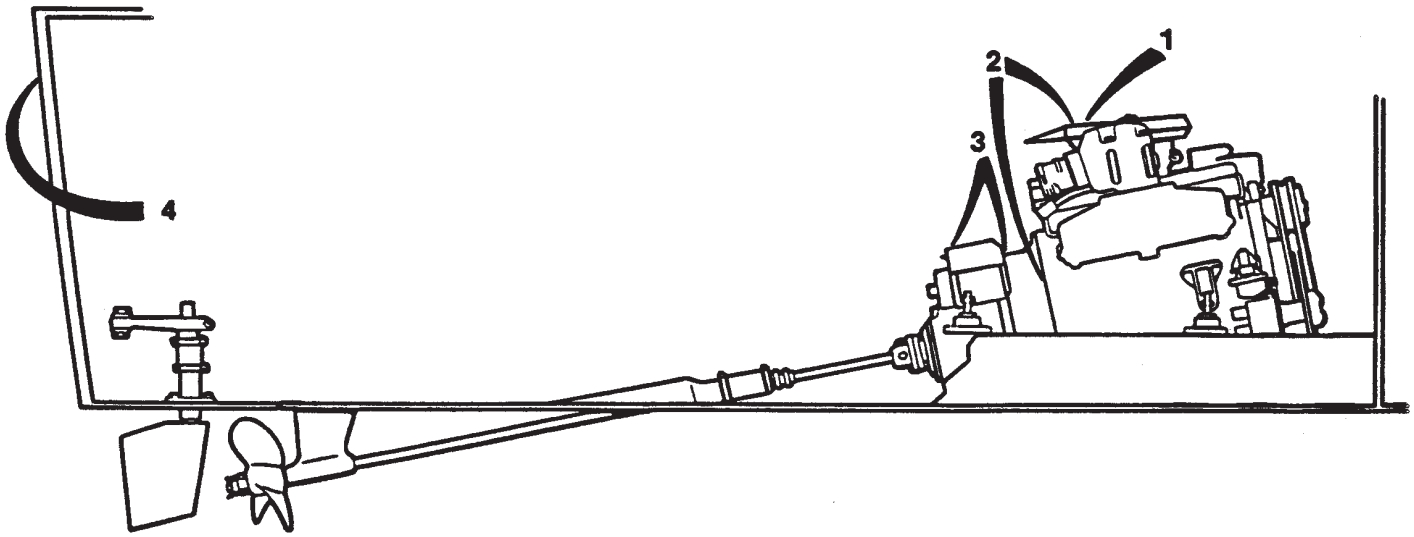
MerCruiser V6

1 – Engine Serial Number & Specifications
2 – Engine Serial Number
* – P/N for Attaching Screw
3 – Transom Serial Number
4 – Drive Serial Number
5 – Propeller Part Number
6 – Propeller Pitch
7 – Vessel Serial Number

MerCruiser Inboard Typical Serial Number Locations

The serial numbers are the manufacturer's keys to numerous engineering details which apply to your MerCruiser® power package. When contacting your Authorized MerCruiser Dealer about service, always specify model and serial numbers.

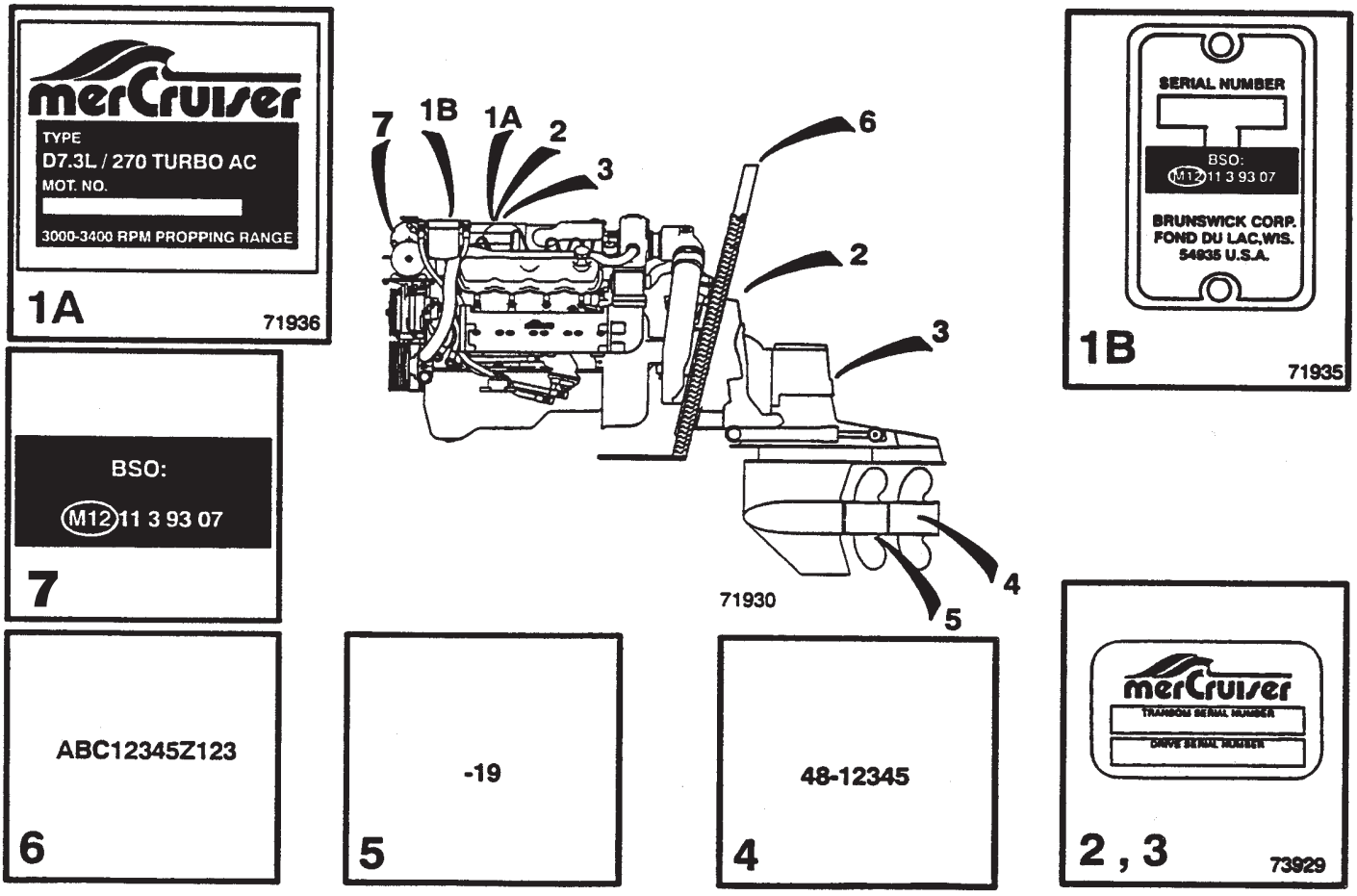




1 – Engine Serial Number & Specifications
2 – Engine Serial Number
3 – Transmission Serial & Model Numbers
4 – Vessel Serial Number

MerCruiser Sterndrive - Diesel Typical Serial Number Locations

The serial numbers are the manufacturer's keys to numerous engineering details which apply to your MerCruiser® power package. When contacting your Authorized MerCruiser Dealer about service, always specify model and serial numbers.



1A– Model & Serial Number Plate

1B– Serial Number Plate

2 – Transom Serial Number

3 – Drive Serial Number

4 – Propeller Part Number

5 – Propeller Pitch

6 – Vessel Serial Number

7 – Exhaust Gas Emissions Certificate Number

Dealer Service Publications

Dealer Publications and Starting Serial Number Guide (830571)

Mercury Precision Parts and Quicksilver Accessories Guide

(dealer version – 42000-XX {US}, 814817-XX {Canada}; consumer version – 18379-XX {US})

MerCruiser Special Tools Catalog (806737003)

Installation Instruction Sheets

Dealer Operations Guide (827690-XX)

Dealer Propeller Guide (859429-XX)

Service Manuals

Service Bulletins

Parts Bulletins

Product Line Familiarization

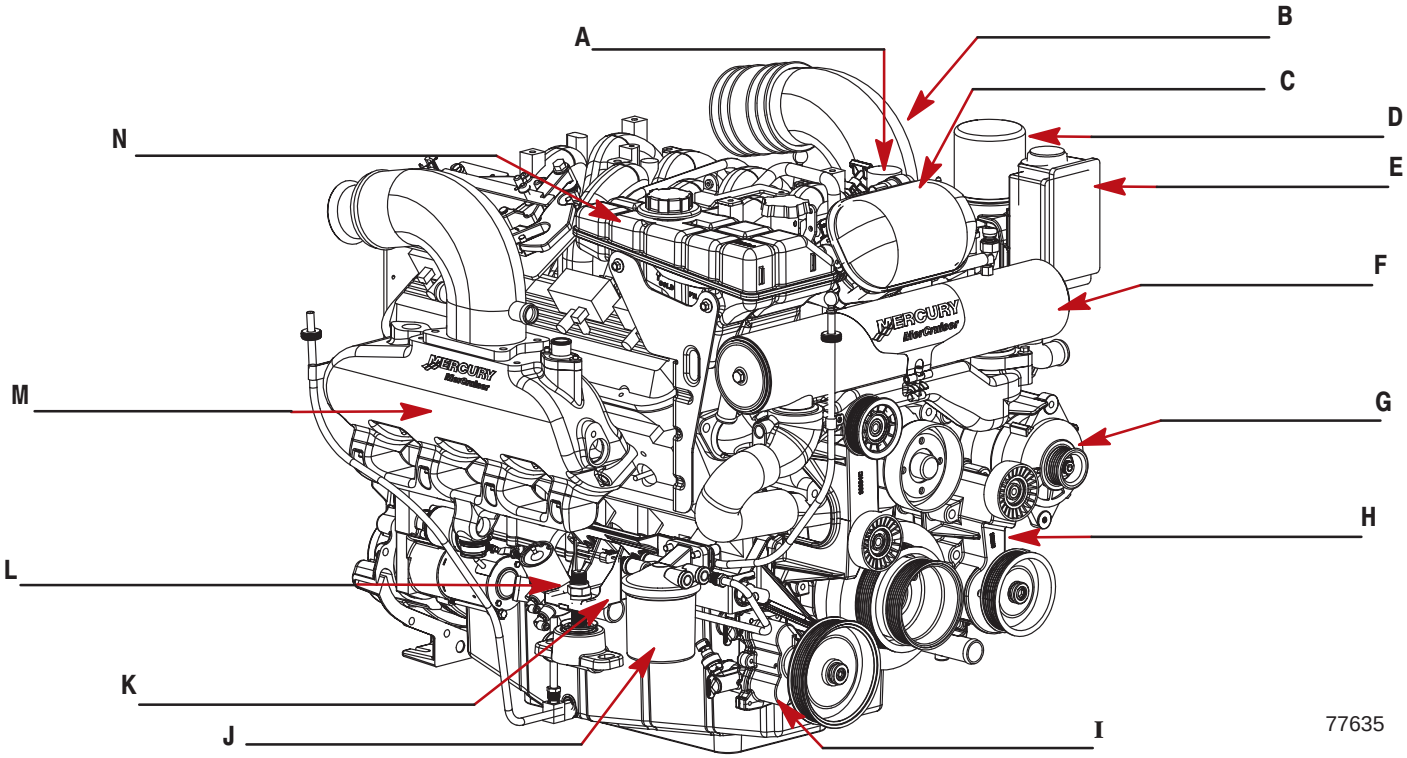
Sterndrives

Ski

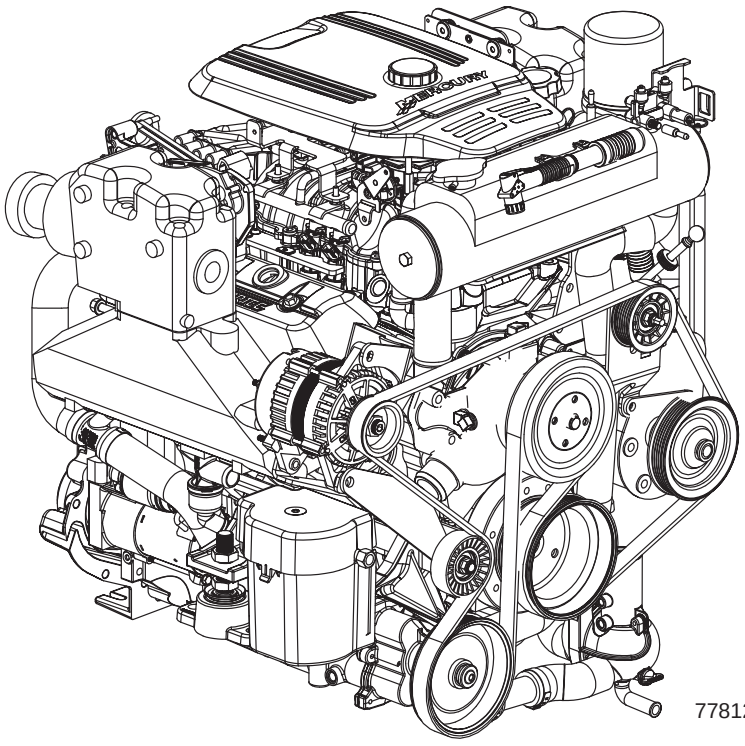
Inboard

MerCruiser Power Package Components
Engines

496 MAGNUM (8.1 SIMILAR)

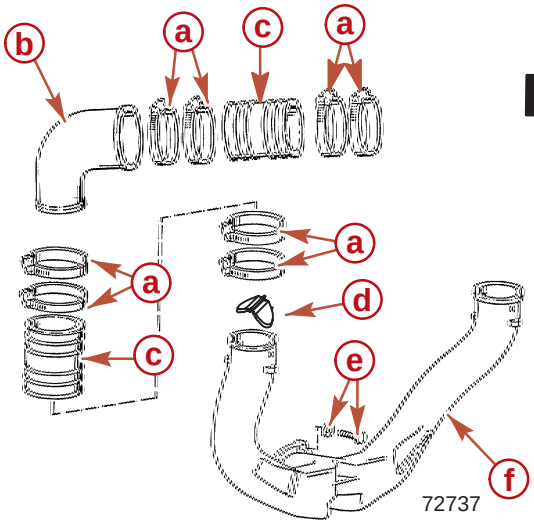


V-6 SHOWN (SMALL BLOCK V-8 SIMILIAR)

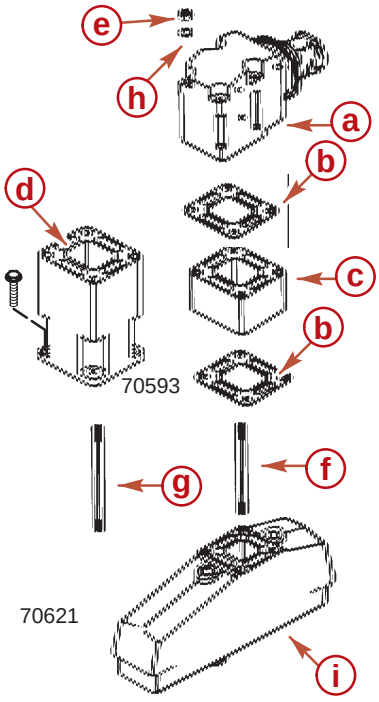


Exhaust Systems

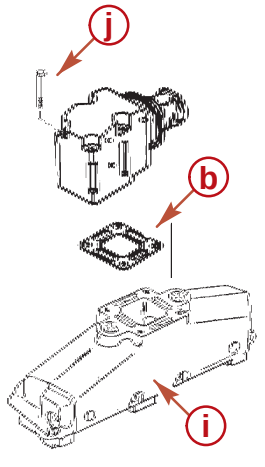
Typical Sterndrive Exhaust Components



- **a** - Clamps
- **b** - Exhaust Pipe Elbow
- **c** - Exhaust Hose
- **d** - Water Shutters
- **e** - Bolts And Lockwashers
- **f** - Exhaust Pipe

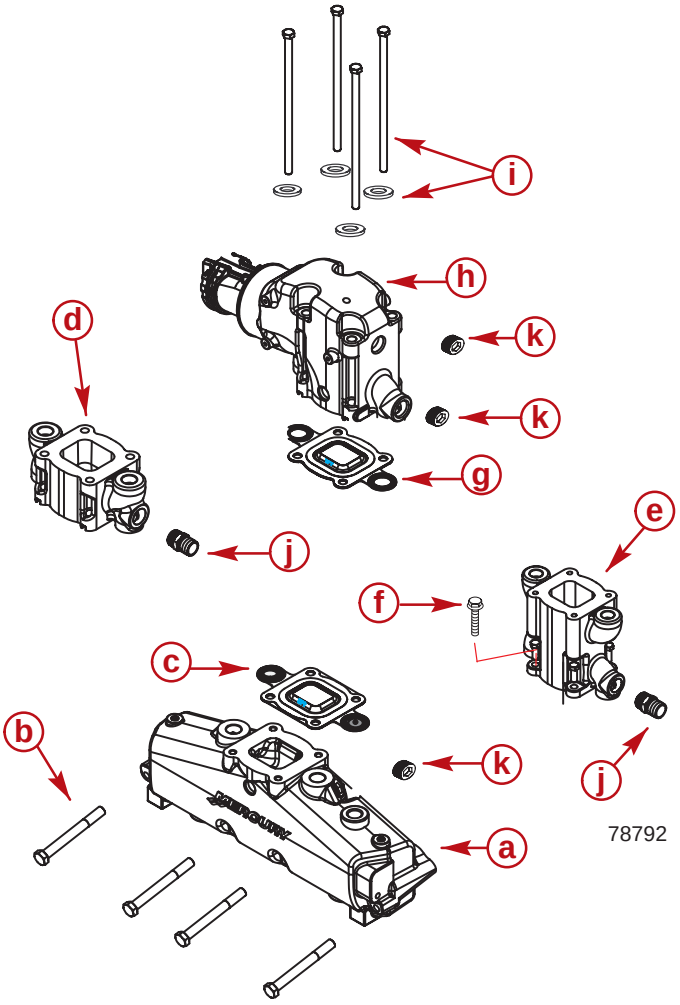


Elbows With Risers



Elbows Without Risers

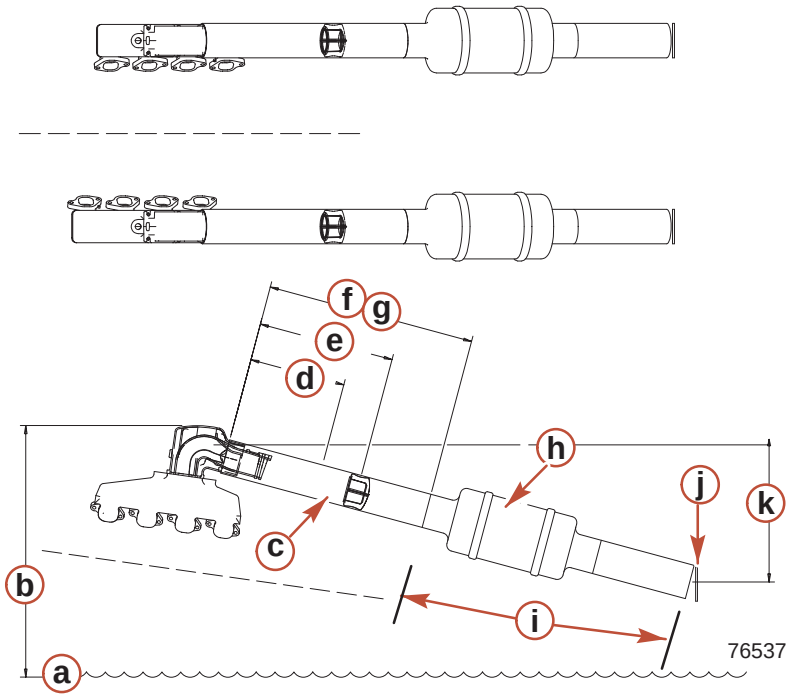
- **a** - Exhaust Elbow
- **b** - 4 Slot Gasket
- **c** - 3 in. (76 mm) Exhaust Riser
- **d** - 6 in. (152 mm) Exhaust Riser
- **e** - Nut (8)
- **f** - Stud (8) 9-3/8 in. (238 mm)
- **g** - Stud (8) 10-3/8 in. (264 mm) Used With Some MIE Remote Oil Filters
- **h** - Washer (8)
- **i** - Exhaust Manifold
- **j** - Bolts



Dry-Joint Exhaust System – V6 and Small Block V8 (S/N MIE 0M317000 and Up – MCM 0M600000 and Up)

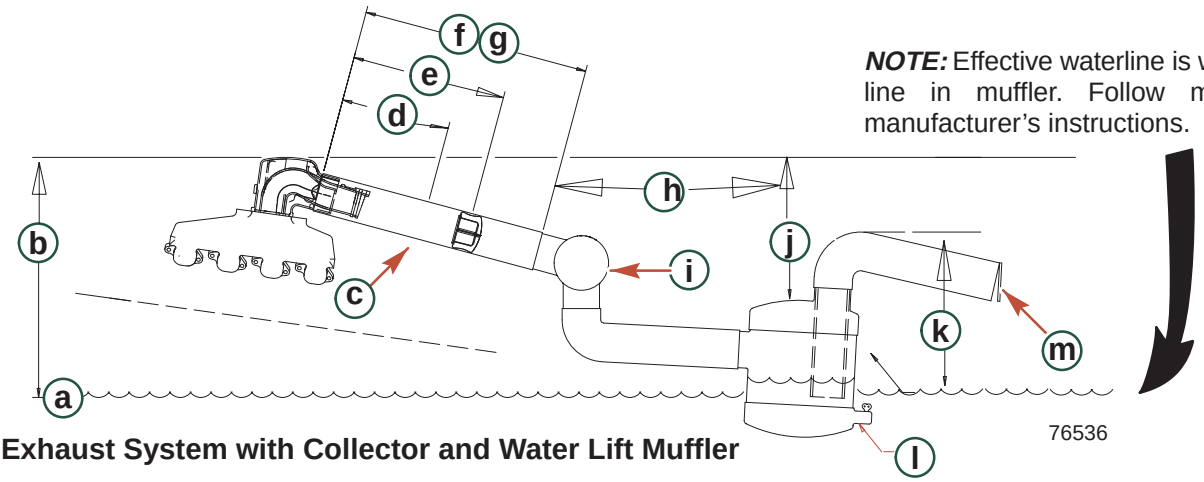
- **a** - Exhaust manifold
- **b** - Manifold-to-cylinder head bolt (4)
- **c** - Restrictor gasket, with turbulator (seawater cooled models)
- **d** - 76 mm (3 in.) cold riser
- **e** - 152 mm (6 in.) cold riser
- **f** - Riser to exhaust manifold screw (4)
- **g** - Full flow gasket, with turbulator
- **h** - Exhaust elbow
- **i** - Exhaust elbow to riser or exhaust manifold screw and washer (4 each)
- **j** - Hose fitting
- **k** - Pipe plug

Typical Inboard Exhaust System Components



Typical Exhaust System with In–Line Mufflers

- **a** - Water Line
- **b** - Minimum Exhaust Elbow Height with Maximum Load 15 in. (381 mm) on 8.1S Models; 13 in. (330 mm) on All Others
- **c** - 4 in. (102 mm) I.D. Minimum Exhaust Hose
- **d** - Exhaust Back Pressure Check Point 12-24 in. (305-610 mm) - 2 psi (13.8 kPa) Max.
- **e** - Resonator Placement 13–17 In. (330–432 mm) If Equipped
- **f** - 18 in. (457 mm) Minimum Between Exhaust Elbow and Muffler
- **g** - 6° Downward Slope Minimum on Conventional Inboards And Skis; 4° on VDrives; ±5° vs. Exhaust Elbow Outlet on 8.1S Models
- **h** - Muffler Should Be Self–Draining
- **i** - Minimum Slope 1/2 in. (13 mm) per Foot (Approx. 3°) In this Region
- **j** - Exhaust Outlets Above Waterline with Maximum Load; Shutters and Flappers Required on All Models Except 8.1S
- **k** - 4 in (102 mm) Drop Minimum

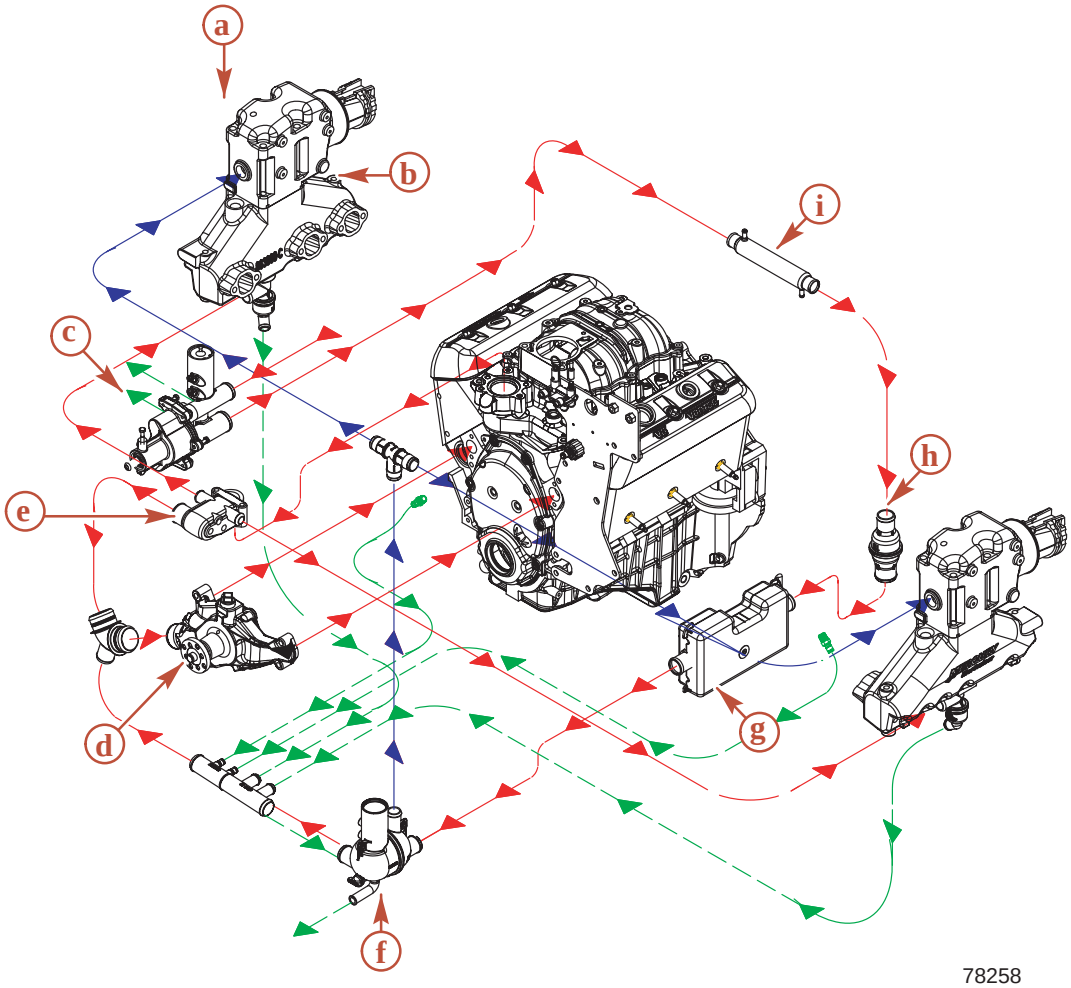


NOTE: Effective waterline is waterline in muffler. Follow muffler manufacturer's instructions.

Typical Exhaust System with Collector and Water Lift Muffler

- **a** - Water Line
- **b** - Siphon Break (Vacuum Valve) Must Be Installed in Cooling Water Circuit If Exhaust Elbows Are At or Below Water Level – See Muffler Manufacturer's Recommendations
- **c** - 4 in (102 mm) Exhaust Hose Minimum; 5 in. [127 mm] Minimum Required for Single Hose Portion on 8.1S Models
- **d** - Exhaust Back Pressure Check Point 12-24 in. (305-610 mm) - 2 psi (13.8 kPa) Max.
- **e** - Resonator Placement 13–17 In. (330–432 mm) If Equipped
- **f** - 18 in. (457 mm) Minimum Between Exhaust Elbow and Collector
- **g** - 6° Downward Slope Minimum on Conventional Inboards; 4° on V–Drives; ±5° vs. Exhaust Elbow Outlet on 8.1S Models
- **h** - Minimum Slope 1/2 in. (13 mm) per Foot (Approx. 3°) In this Region
- **i** - Collector (See Information on Previous Drawing)
- **j** - Muffler Must Be Positioned per Manufacturer's Specified Distance Below Exhaust Elbows
- **k** - Muffler Riser Must Extend Manufacturer's Specified Distance Above Water Line
- **l** - Drain Cock
- **m** - Exhaust Outlets Above Waterline with Maximum Load; Shutters and Flappers Required on All Models Except 8.1S

Cooling System

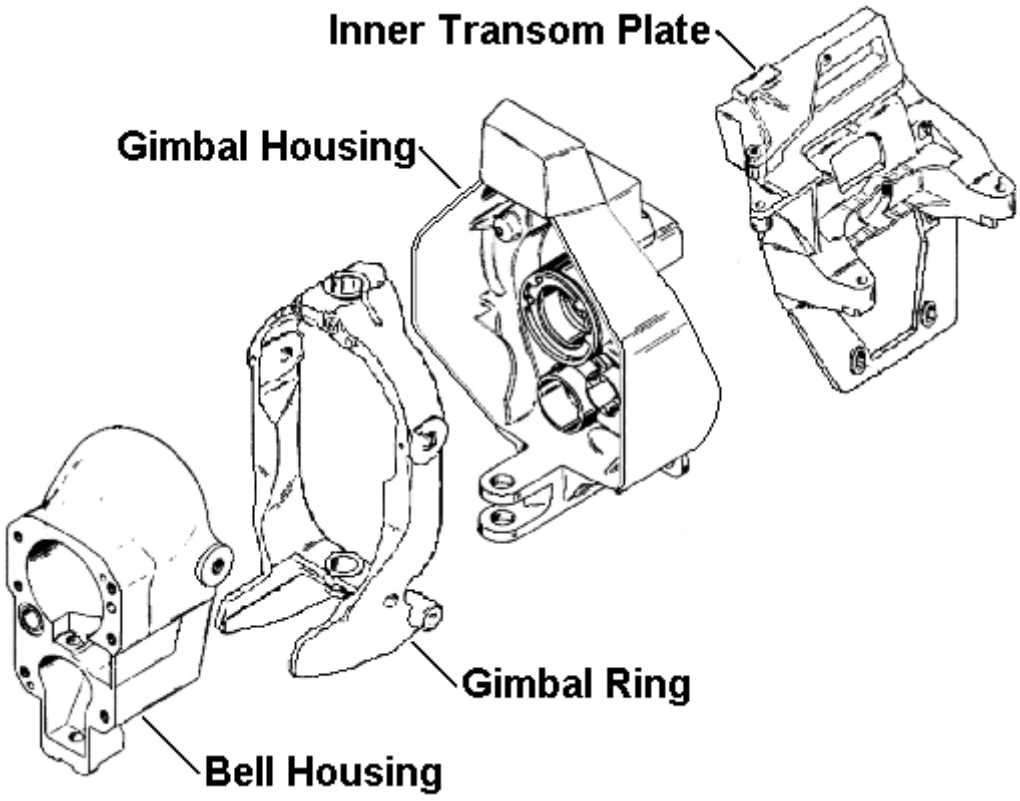


78258

a - Exhaust Elbow
b - Exhaust Manifold
c - Seawater Pump
d - Water Circulating Pump
e - Thermostat Housing
f - Water Distribution Housing
g - Cool Fuel Box
h - Check Valve
i - Power Steering Cooler

See MC Service Bulletin 97-19 for pertinent information.

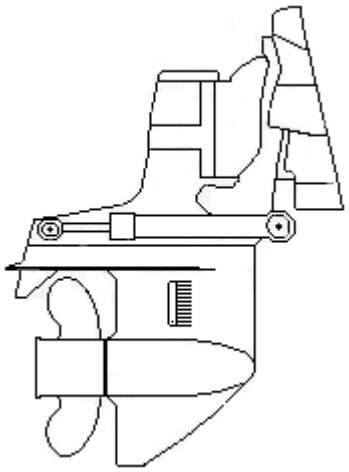
Transom Assembly



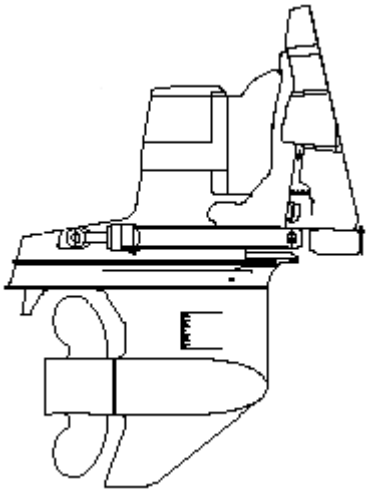
MerCruiser Drives (Typical)



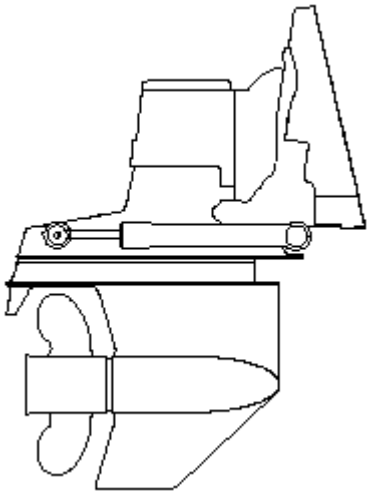
MC-I



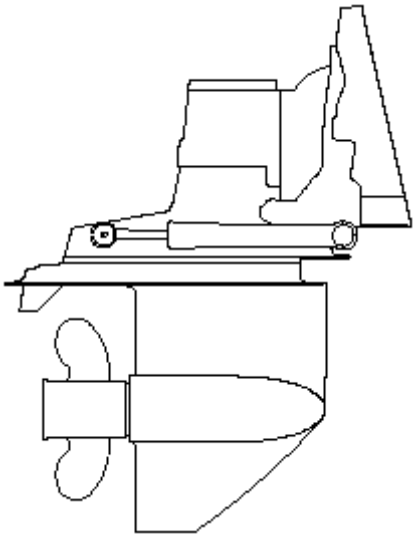
MC-IR, MR, Alpha I



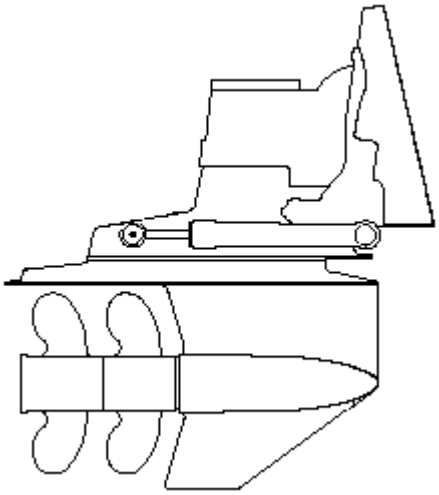
Alpha I, Gen II



Bravo I



Bravo II



Bravo III

MERCRUISER PDI AND MAINTENANCE – LEVEL I

1 B

ENGINE INSTALLATION AND ALIGNMENT

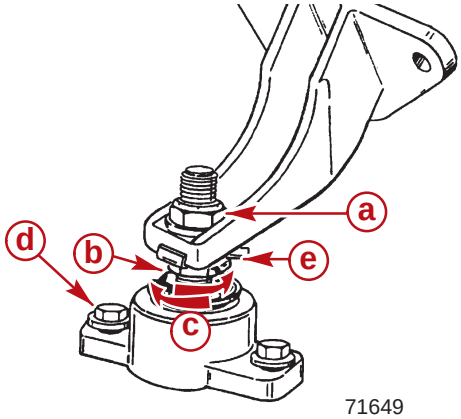
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Engine Mounts

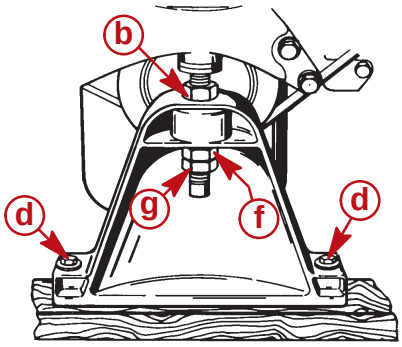
Front engine mounts are adjustable and must rest on boat stringers. 3/8 in. lag screws or bolts, depending upon stringer construction, retain engine mount pedestal to stringer. Grade and length of lag screws or bolts, must be selected based on stringer material and anticipated loading forces. Washers with locking tabs are employed to avoid mounts loosening.

Adjustment nut is turned counterclockwise to raise front of engine, or clockwise to lower front of engine.



71649

Typical V-6 or V-8 Front Mount

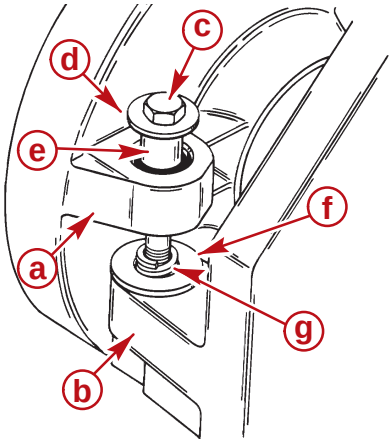


22054

3.0L (181 cid) Front Mount

- **a** - Nut And Lockwasher
- **b** - Adjustment Nut
- **c** - Adjustment Nut
- **d** - Lag Screws Or Bolts
- **e** - Tab Washer
- **f** - Locknut
- **g** - Jam Nut

Rear engine mounts are provided to align with inner transom plate mounts.



22032

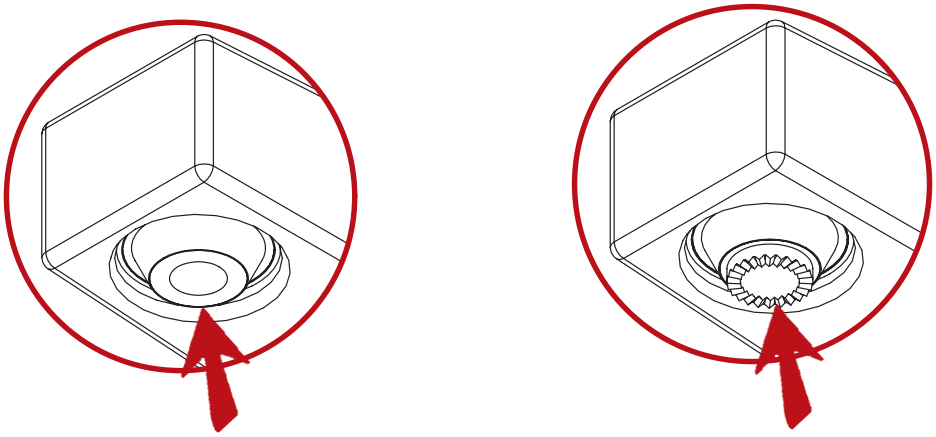
Typical Rear Mount

- **a** - Rear Engine Mount
- **b** - Inner Transom Plate Mount
- **c** - Bolt
- **d** - Washer
- **e** - Spacer
- **f** - Fiber Washer
- **g** - Double-Wound Lockwasher

New MerCruiser Sterndrive Rear Engine Mounts

Starting Serial Number: 0M660000.

Do not use double-wound lockwashers on the inner transom plate with quick rear mounts.

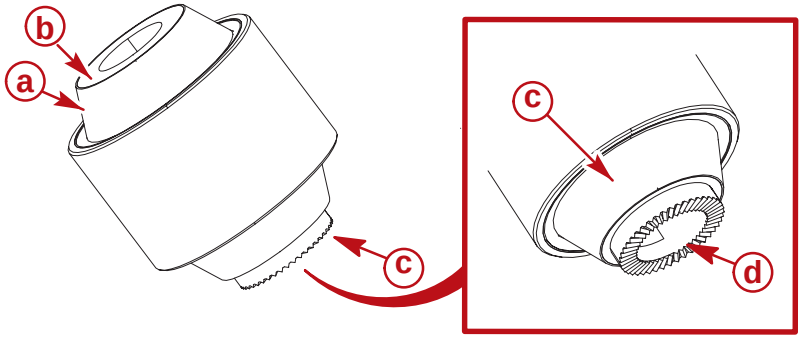


79430

Standard rear mount - smooth edge **Quick rear mount - knurled edge**

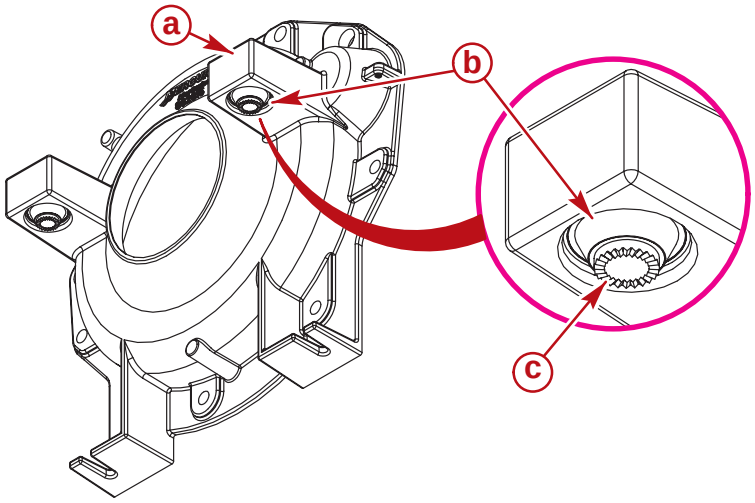
1. Install the spacer into the flywheel housing.

IMPORTANT: The white (865329) or yellow (865330) paint identifies the top of the mount assembly. The bottom has a knurled edge.



79435

a - Painted top
b - Smooth edge
c - Bottom end
d - Knurled edge

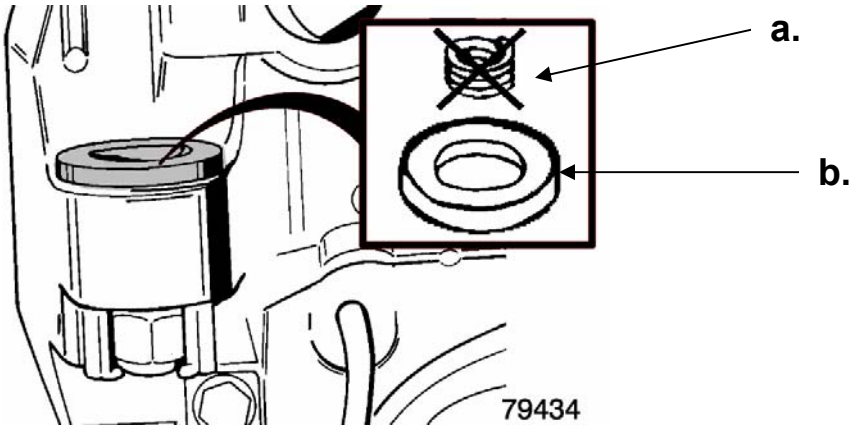


79433

Typical flywheel housing, all similar

a - Painted end (not visible)
b - Mount bottom
c - Knurled edge

2. **On all inner transom plates.** If equipped, remove and discard the double-wound lockwashers on the inner transom plate mounts.



Typical starboard inner transom plate mount, port similar

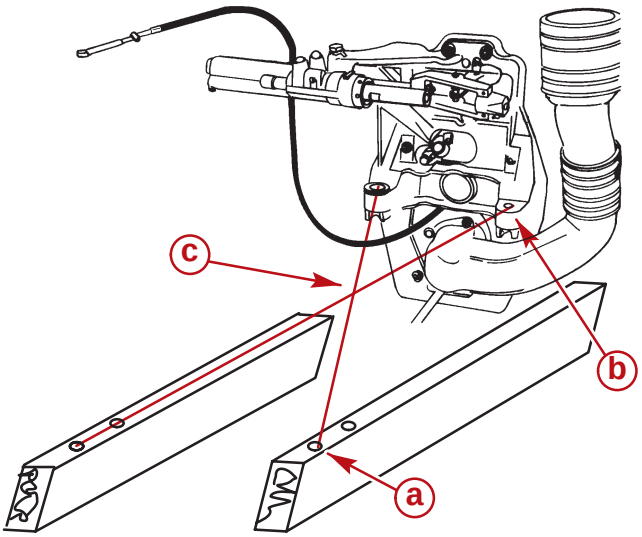
a - Double-wound lockwasher
b - Fiber washer

Engine Alignment

Checking Stringer Height

To achieve approximately equal front mount adjustment, ensure that the stringers are equal in height before installing the engine. This may be checked by tying a string from the port front mount location to the starboard rear engine mount on transom assembly. Another string should be tied from starboard front to port rear. The strings should lightly touch where they cross. If not, corrections should be made to the engine bed.

Refer to product Installation Drawings for complete information about stringer height.

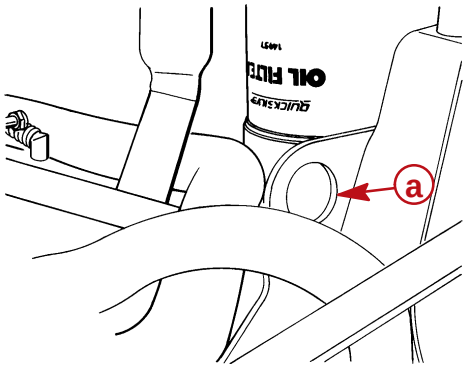


74903

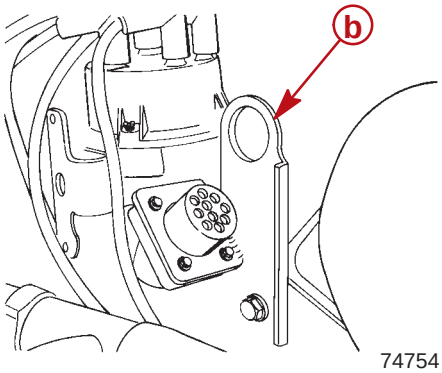
a - Front of Stringer
b - Rear Mount
c - Strings Cross

Suspending The Engine

Front and rear lifting eyes on the engine are provided to allow attachment of a suitable sling. The engine can then be lifted into position (in boat) using an overhead hoist. Center mounted lifting eyes are for engine alignment ONLY and should never be used to lift an entire engine.



74760



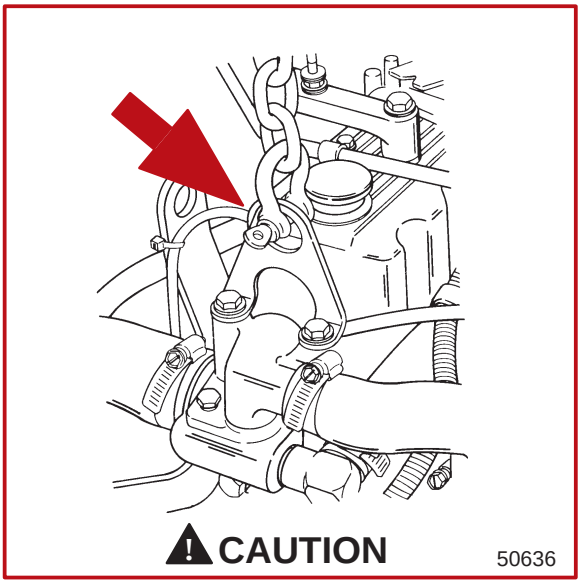
74754

Typical Engine Lifting Eyes

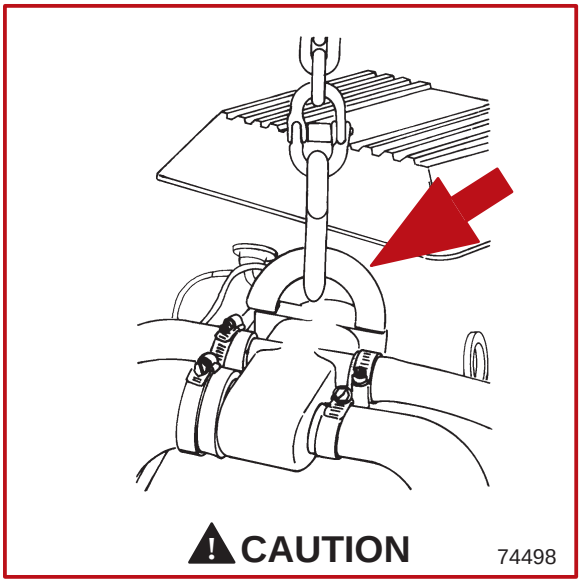
a - Front
b - Rear

⚠ CAUTION

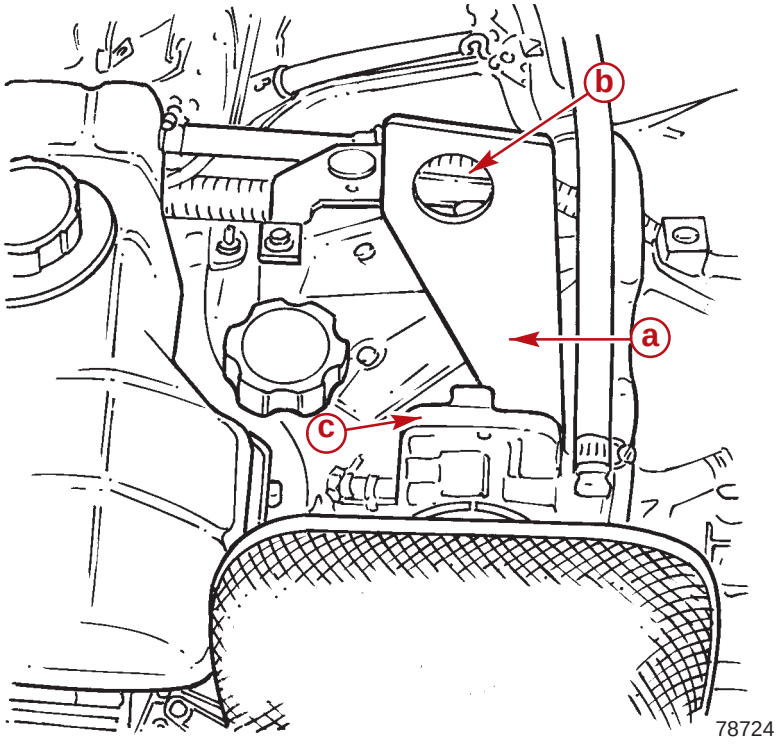
Avoid product damage or injury. Center lifting eye (if equipped), on top of thermostat housing, is used for engine alignment only. Do not use to lift entire engine.



Center Lifting Eye – 3.0L



Typical Center Lifting Eye – V6 and V8



496 Magnum Alignment Lifting Hook - P/N 863375-A1

a - Alignment Hook
b - Lifting Eye
c - Throttle Body Flange

Alignment Tool Requirements

A special tool is required to align the engine and the sterndrive unit during engine installation. Refer to the specific Installation Manual packaged with the product for complete information and procedures.

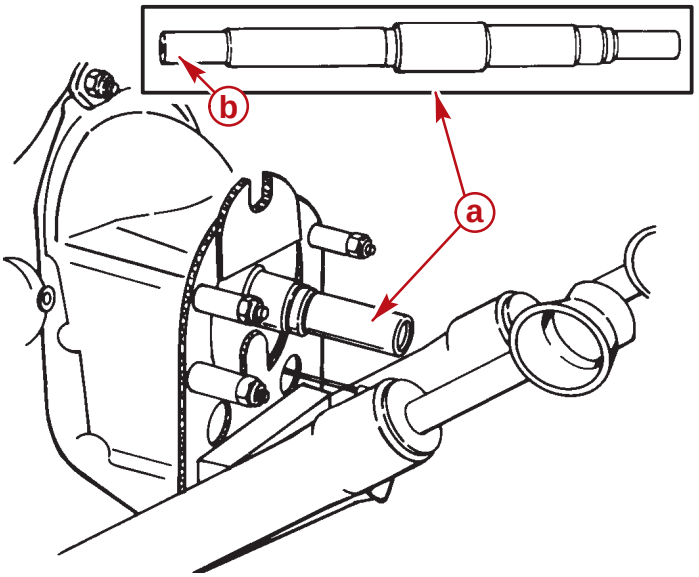
⚠ CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool may cause improper alignment and damage to gimbal bearing and/or engine coupler.

⚠ CAUTION

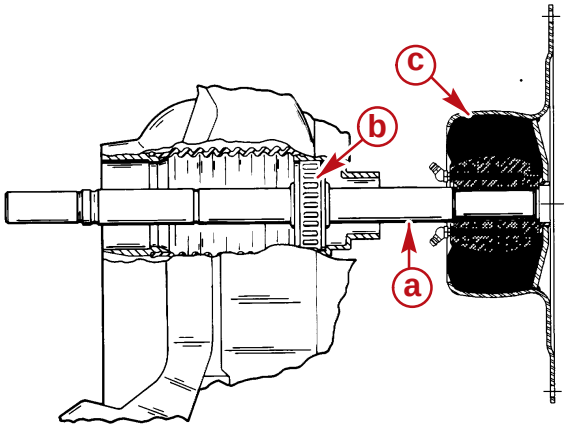
To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**



22029

a - Alignment Tool (use only recommended alignment tool)
b - This End Of Alignment Tool Inserts Through Gimbal Housing Assembly



27647

a - Alignment Tool
b - Gimbal Bearing
c - Engine Coupler

NOTE: *"X" Dimension refers to point on boat transom that is extension of engine crankshaft centerline.*

Final Engine Mount Height Adjustment

IMPORTANT: Finished boat stringer must position engine so that a minimum mount adjustment exists after front mount is adjusted down to stringer. This allows for future adjustments.

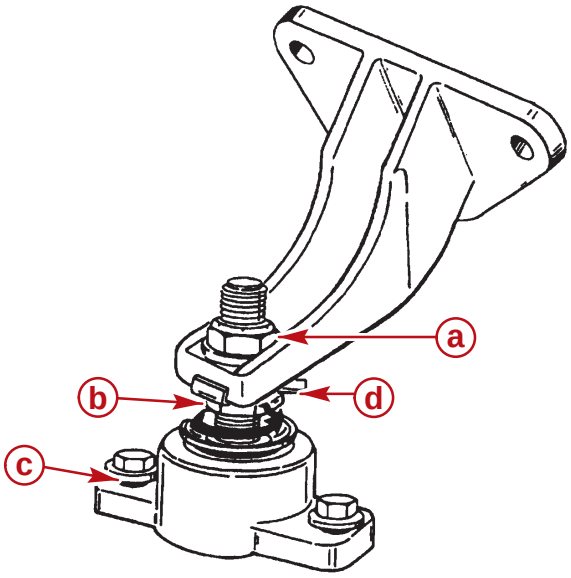
IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

During final engine mount adjustment, the mounts are temporarily adjusted until they rest on the stringers. Hoist tension is relieved so that the engine settles onto the stringers and the mounts are appropriately fastened to stringers. Common attachment is using 3/8 in. (9 mm) lag bolts.

Both adjustment nuts must be turned equally for proper alignment. Alignment must be checked with the sterndrive alignment tool during the final engine mount height adjustment.

The tool must enter coupling splines freely. When this is possible final adjustment is complete. The locknuts on the mounts should be secured by bending the locking tabs onto the adjusting nuts.

NOTE: *Ensure that the alignment tool is removed after alignment.*



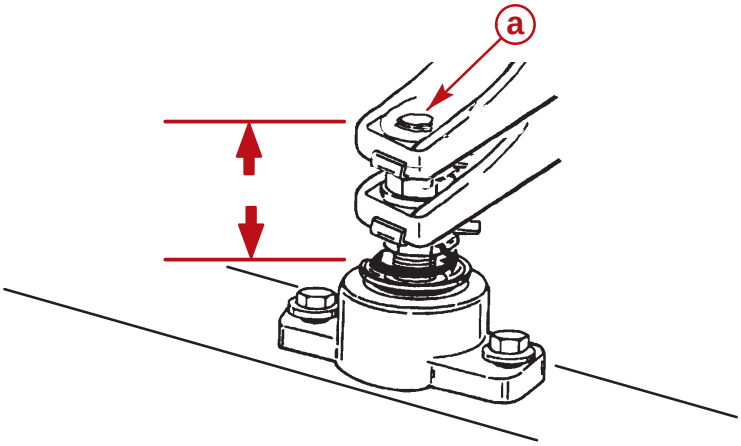
71649

Typical Front Mount

- **a -** Nut And Lockwasher
- **b -** Adjustment Nut
- **c -** Slotted Hole Toward Front Of Engine
- **d -** Tab Washer

⚠ CAUTION

Avoid damage to exhaust system. On V6 Models with one-piece exhaust manifolds, stress can be placed on the lower exhaust pipe if front of engine is raised too high while performing engine alignment. Ensure that engine is not raised higher than the top of engine mount adjusting stud.



75129

V-6 Models With One-Piece Exhaust Manifolds

a - Top of Stud

Engine Installation

Gear Lube Monitor

GENERAL INFORMATION

To help avoid operating the sterndrive unit without sufficient gear lube, a Gear Lube Monitor is provided with the power package. This includes connections to the Audio Warning System, except on 3.0L models.

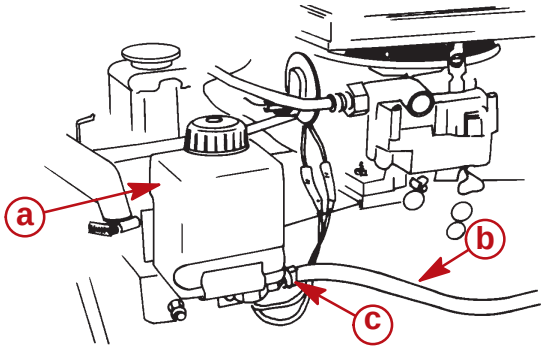
The bracket and gear lube bottle are factory mounted. However, proper hose routing and connection are required for the system to operate. The following information is provided to assist in understanding the system. Refer to the Installation Manual packaged with the power package for more information.

IMPORTANT: Avoid using excessive hose when routing to gear lube monitor. Hose should be routed directly to gear lube monitor in as straight a line as possible to avoid low spots (traps) in the system.

⚠ CAUTION

Ensure that hose is not kinked when connected. If hose is kinked, gear lube monitor will not function properly and damage to sterndrive unit could occur.

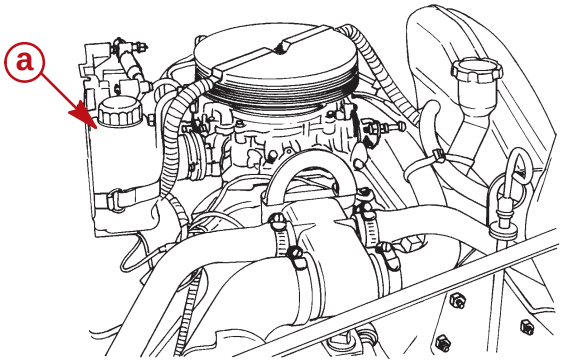
Secure with hose clamp after properly routing the hose.



71982

181 cid/3.0L Model

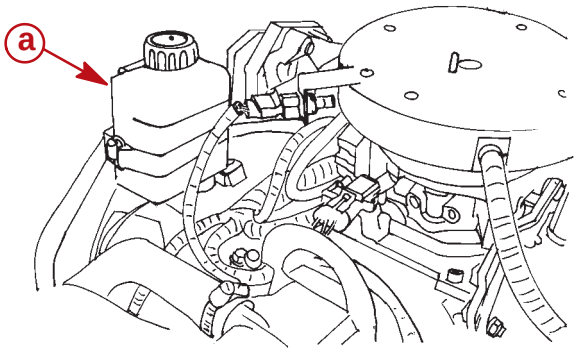
- **a** - Gear Lube Monitor
- **b** - Hose
- **c** - Clamp



75847

262cid/4.3L With Single Piece Manifolds

- **a** - Gear Lube Monitor

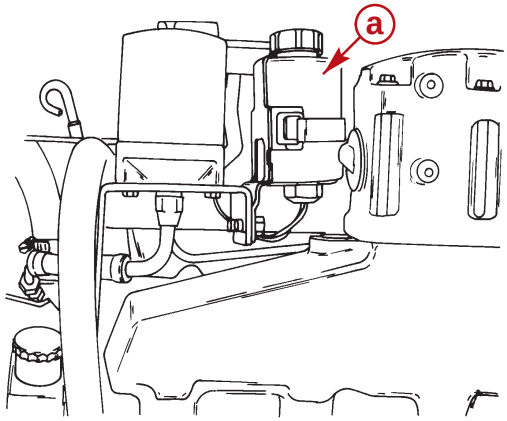


76230

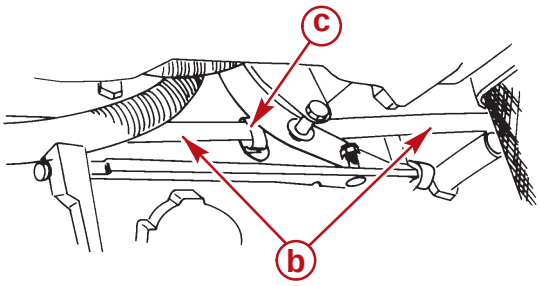
305 cid/5.0L and 350 cid/5.7L

a - Gear Lube Monitor

On 454 cid/7.4L and 502 cid/8.2L Models: also secure hose with J-Clip that is attached to the valve cover.



75444

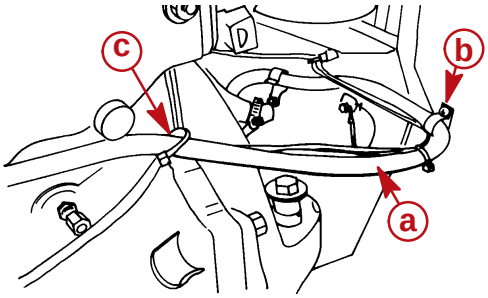


71991

454 cid/7.4L and 502 cid/8.2L Models

a - Gear Lube Monitor
b - Hose
c - J-Clip on Valve Cover

Depending upon application, extra hose clips may be required to secure hose to transom.



71984

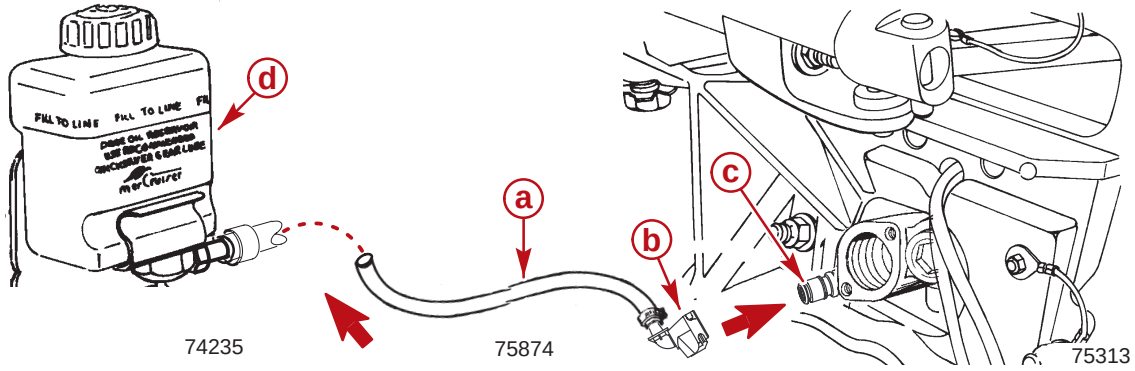
181 CID/3.0L Model Shown (All Similar)

a - Hose
b - Hose Clip
c - Sta-Strap

GIMBAL HOUSING CONNECTION

The gear lube monitor hose is connected to a quick release 90° fitting. This fitting is then connected to the gimbal housing.

IMPORTANT: Hose must not come in contact with steering system components or the engine coupler, U-joint shaft or drive shaft.

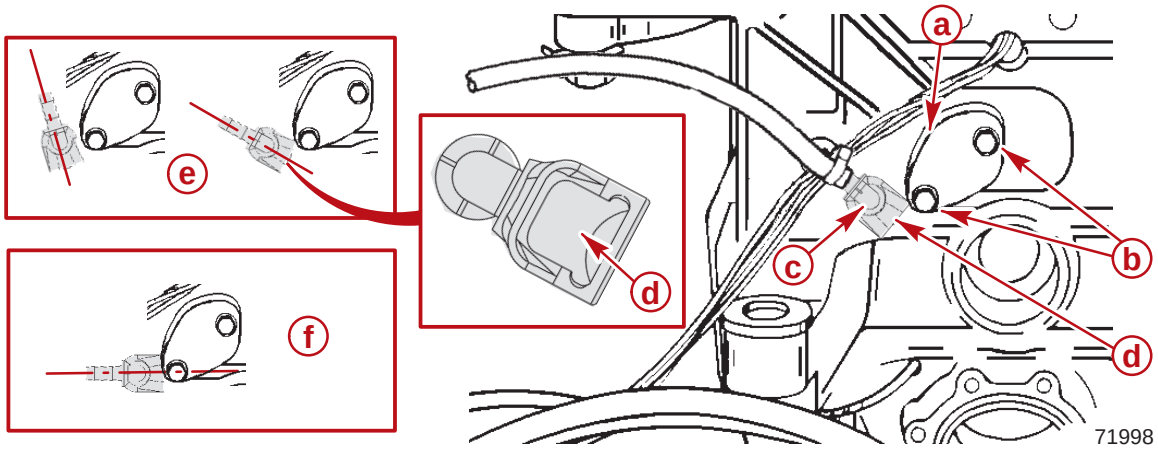


a - Hose
b - 90° Hose Fitting
c - Gimbal Housing Fitting
d - Gear Lube Monitor

On Bravo sterndrive units the quick release button on hose fitting must be positioned away from water inlet fitting, or block-off plate, if equipped. Release button must not contact water fitting, or block-off plate if equipped.

⚠ CAUTION

Avoid sterndrive unit damage. Quick release button on gear lube monitor 90° hose fitting may not lock on gimbal housing if touching or depressed by water inlet fitting, or block-off plate, if equipped. Ensure quick release button does not contact block-off plate, or water inlet fitting if equipped. Failure to do so could result in a loose 90° fitting causing a loss of gear lube and damage to drive unit.

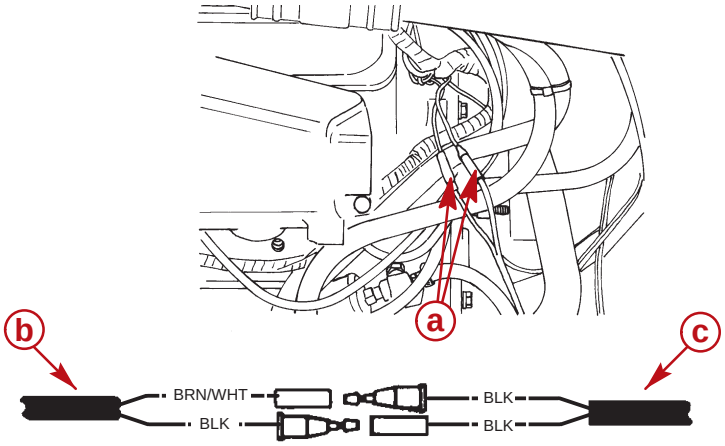


Block-Off Plate Installation Shown (Similar For Models With Water Fitting)

a - Block-Off Plate (Or Water Inlet Fitting If Equipped)
b - Star Washer and Screw
c - 90° Hose Fitting
d - Quick Release Button
e - ACCEPTABLE Positions
f - NOT ACCEPTABLE Position

Trim Position Sender Harness

Mercury MerCruiser provides an instrumentation harness that includes trim position sender wiring. The installer must connect the trim position sender wires (from transom assembly) to engine harness. The instrumentation package must include a trim position gauge.



74029

V6 and V8 Models (3.0L Similar)

- **a -** Engine Harness Bullet Connectors
- **b -** Engine Harness
- **c -** Transom Assembly Wires

SmartCraft Transoms

The port side sender has a 3-wire quick connector that goes to the SmartCraft Transom Harness on the engine. It sends a signal to the ECM (that processes both trim limit and trim position information) and then a signal is sent to the trim pump or SmartCraft gauges, as required. Key switch must be “ON” for trim limit to function.

The starboard side trim position sender is for use with older analog trim gauges.

Power Steering Hose Routing

IMPORTANT: When installing power steering hoses observe the following.

- **Make hydraulic connections as quickly as possible to prevent fluid leakage.**
- **Be careful not to cross-thread or overtighten fittings.**

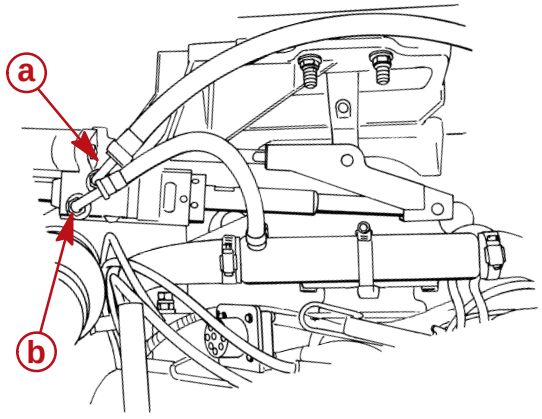
Power steering fluid hoses are provided with the power package. Proper routing and installation of the hoses is required to avoid problems related to power steering system.

Observe the following:

- Hoses must be routed over top edge of transom plate.
- Hoses must be secured to avoid contact with moving components.
- Torque both power steering hose fittings to 23 lb-ft (31 Nm) after connecting to control valve.

⚠ CAUTION

Avoid stress on the hose fittings and avoid kinks in the hoses. Install and route power steering hoses exactly as shown in specific Installation Manual provided with power package.



75117

Example Of Power Steering Hose Routing and Fittings At Control Valve

a - Rear Fitting (Pressure Hose)
b - Front Fitting (Return Hose)

NOTE: *When routing power steering hoses, avoid sharp bends.*

Exhaust Hose Routing

Exhaust hose routing is dependent upon the various power package and boat designs. However, in all cases, care must be exercised in the proper installation of an exhaust hose (tube), or hose may fail.

⚠ CAUTION

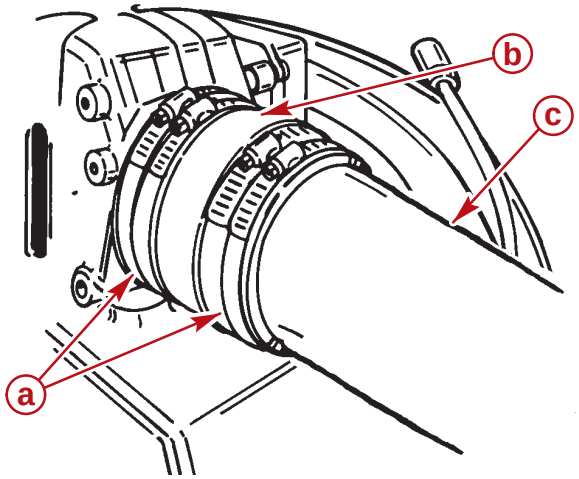
Avoid exhaust hose failure. Discharge water from exhaust elbow must flow around entire inside diameter of hose to avoid causing hot spots that could eventually result in burned-through exhaust hoses. Exhaust hoses and/or tubes must be correctly connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow.



71653

Correct Connection **Incorrect Connection**

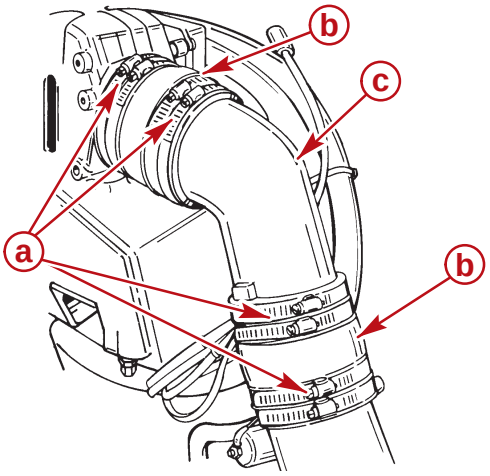
A designer, or the installer, may require an installation similar to one of the following four examples. All exhaust hoses and / or tubes must be secured with two clamps at each connection.



73961

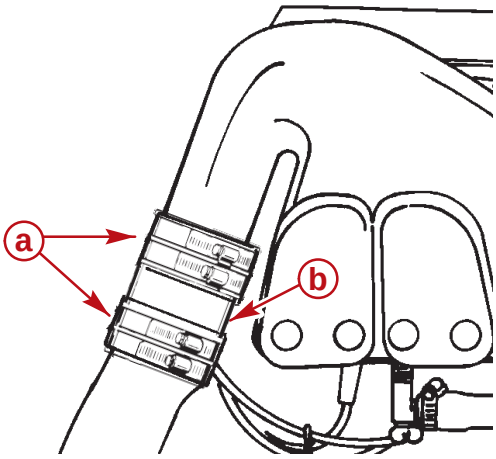
V8 Models - Through Transom Exhaust

- **a** - Hose Clamps
- **b** - Exhaust Hose (Tube)
- **c** - Exhaust Pipe



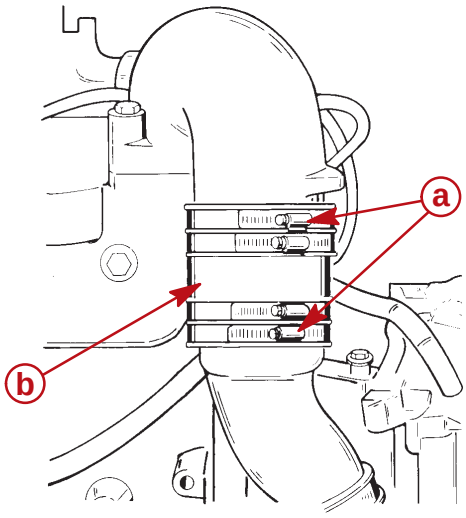
22059

V6 with 2-piece Exhaust Manifold and V8 Models - Through Propeller Exhaust



74773

V6 Models - Through Propeller Exhaust (One-Piece Exhaust Manifolds)



50633

3.0L Models - Through Propeller Exhaust

a - Hose Clamps
b - Exhaust Hose (Tube)
c - Exhaust Pipe Elbow

Methods of Measuring Exhaust Elbow Height

The following information outlines two different methods of measuring exhaust elbow height to determine if risers are needed. Refer to *Measuring Procedures* for instructions on proper loading of the boat and complete measurement instructions.

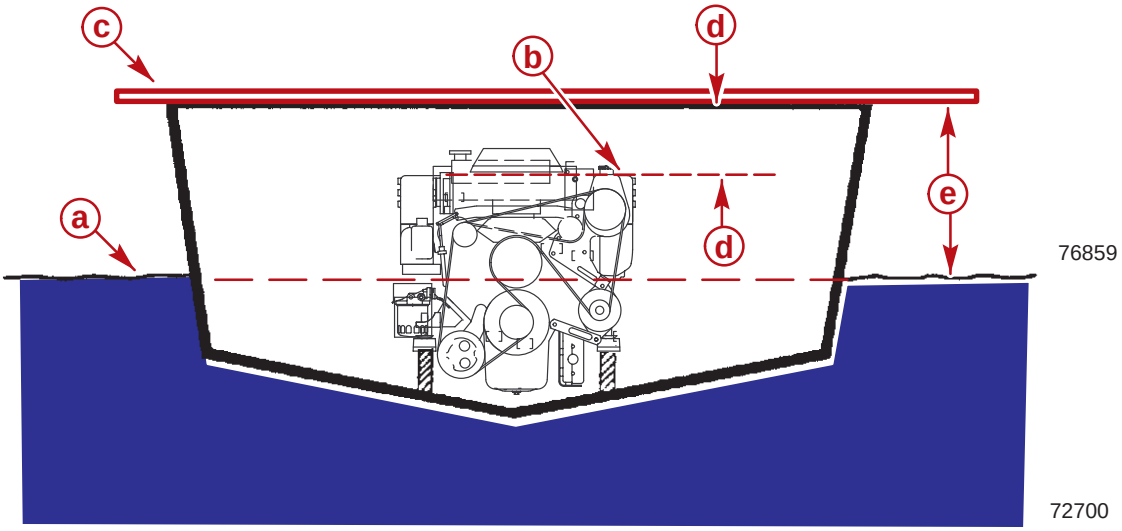
Straight Edge Method

TOOLS

Description	Part Number
Tape Measure	Obtain Locally
Straight Edge (long enough to cross port to starboard gunwales)	

INSTRUCTIONS

1. Place a long straight edge across boat.
2. With the straight edge above the engine and parallel to the water, measure the distances between the straight edge and the top of the exhaust elbow.
3. With the straight edge above the engine and parallel to the water measure the distance between the straight edge and the outside waterline.
4. The difference between these two measurements is the exhaust elbow height above the water line. Refer to *Measuring Procedure* and compare measurement to Mercury MerCruiser's specifications.



Straight Edge Method For Measuring Exhaust Elbow Height

- **a** - Waterline Outside of Boat
- **b** - Top Of Exhaust Elbow
- **c** - Straight Edge
- **d** - Measurement Between Straight Edge And Top Of Exhaust Elbow
- **e** - Measurement Between Straight Edge And Water Line

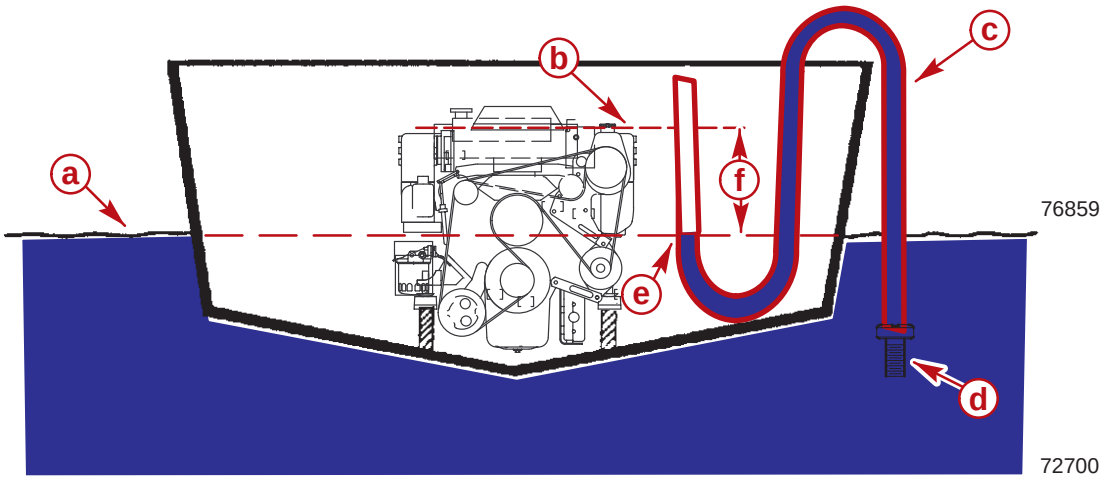
Clear Hose Method

TOOLS

Description	Part Number
Tape Measure	Obtain Locally
5/16-3/8 in. (8-10 mm) Clear Plastic Hose, 15 ft. (4.5 m) Long	
Metal Fitting or Weighted Object (To attach to one end of plastic hose)	

INSTRUCTIONS

1. Ensure that the boat is at rest in the water.
2. Put a metal fitting or a weight on one end of the clear plastic hose. The weight helps keep that end of the hose below the water line.
3. Put the weighted end of the hose over the port or starboard side of the boat, keeping it in line with the engine's exhaust elbow.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow
5. Coil excess hose in bilge of boat, keeping it below the boat's water line.
6. Lower open end of hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.
7. Slowly take finger off end of hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep hose close to exhaust elbow and as vertical as possible.
8. The measurement between water in hose and top of exhaust elbow is the exhaust elbow height.



Clear Hose Method For Measuring Exhaust Elbow Height

- **a** - Waterline Outside Of Boat
- **b** - Top Of Exhaust Elbow
- **c** - 5/16-3/8 in. (8-10 mm) Clear Plastic Hose, 15 ft. (4.5 m) Long
- **d** - Weighted Hose End In Water
- **e** - Waterline Level (Equal To Waterline Level Outside Of Boat)
- **f** - Measurement – Waterline To Top Of Exhaust Elbow

9. Refer to *Measuring Procedure* for measurement instructions

NOTE: *Remember that moving weight and people around in the boat will change the water level in the hose.*

10. After measurement is taken, lift weighted end of hose above water line and drain clear plastic hose. Refer to *Measuring Procedure* and compare measurement to MerCruiser's specifications.

Priming Engine with Oil

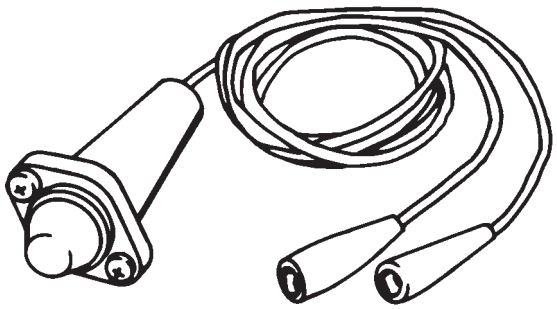
IMPORTANT: This applies to all power packages that have not been run within 6 months, replacement of partial engines or after rebuilding an engine.

⚠ WARNING

Ground the ignition coil wire (that goes to the distributor cap) directly to engine ground stud to prevent a possibility of a spark from the disconnected spark plug wires.

IMPORTANT: When using a Remote Starter tool to crank the engine over, some engines may have the ignition coil energized by the 'R' terminal in the starter solenoid even though the key switch and the Lanyard Stop Switch are in the 'off' position.

Tool Required



71089

Remote Starter Kit (91-52024A1)

1. Fill crankcase to proper level with the recommended engine oil.
2. Remove spark plugs.
3. Leave ignition key in "OFF" position.
4. Connect remote starter switch to large 12 V terminal (RED battery cable) and small terminal (YELLOW/RED) wire on starter motor.
   a. If remote starter switch is not available, disconnect PURPLE wire from ignition coil before using key switch to crank the engine over. Tape terminal on PURPLE wire to prevent it from touching ground.
5. Crank engine for 15 seconds, then allow starter motor to cool down for 1 minute. This should prevent starter motor from overheating.
6. Repeat this process until a total of 45 seconds of cranking time is achieved.
7. Remove remote starter switch.
   a. If key switch was used, reconnect PURPLE wire to ignition coil.
8. Install spark plugs and wires
9. Supply cooling water to seawater pump and start motor.

MERCRUISER PDI AND MAINTENANCE – LEVEL I

1C

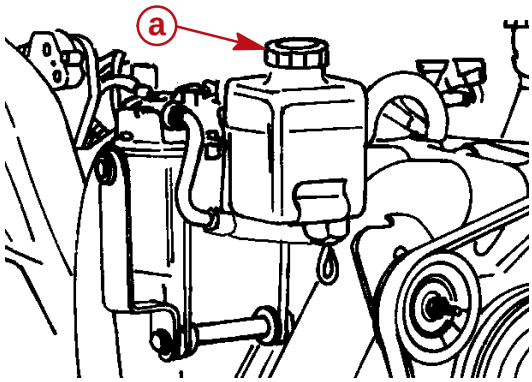
STERNDRIVE INSTALLATION

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Alpha Sterndrive Unit Installation

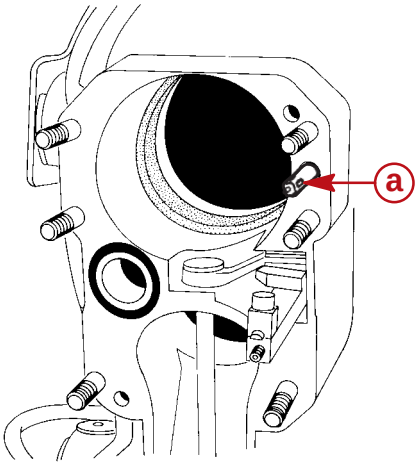
1. Remove trim cylinder support and dust cover from bell housing studs. (Retain elastic stop nuts and flat washers.)
2. Remove gear lube monitor bottle cap. Fill with gear lubricant.



75404

a - Cap

3. Push dribble valve stem in until gear lube appears.



75531

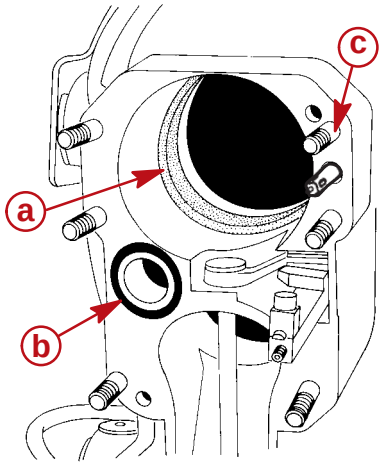
a - Dribble Valve Stem

4. Once gear lube appears, release dribble valve stem.
5. Fill monitor to FULL mark.
6. Replace monitor cap.

IMPORTANT: Rubber gasket must be properly positioned and glued in bell housing bore before installing drive unit or water may leak into boat.

7. Ensure that rubber gasket and water passage O-ring are properly positioned in bell housing. The rubber gasket must be glued in place or water may leak into the u-joint bellows and then into the boat.

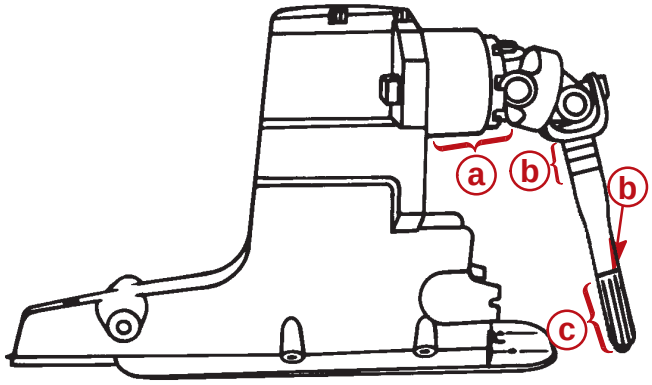
8. Coat entire stud and threads with 2-4-C Marine Lubricant with Teflon.



75531

a - Rubber Gasket
b - Water Passage O-Ring
c - Studs

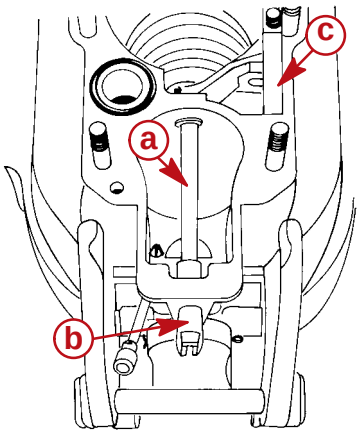
9. Coat drive unit pilot, drive shaft O-rings, and drive shaft splines with Quicksilver Engine Coupler Grease, 92-816391A4.



70114

a - Drive Shaft Pilot
b - Drive Shaft O-Rings
c - Drive Shaft Splines

10. Position bell housing shift shaft coupler so that slot in coupler is positioned straight fore and aft. Do this by placing remote control shift lever in: **Forward gear position for RH drive** or **Reverse gear position for LH drive unit**.

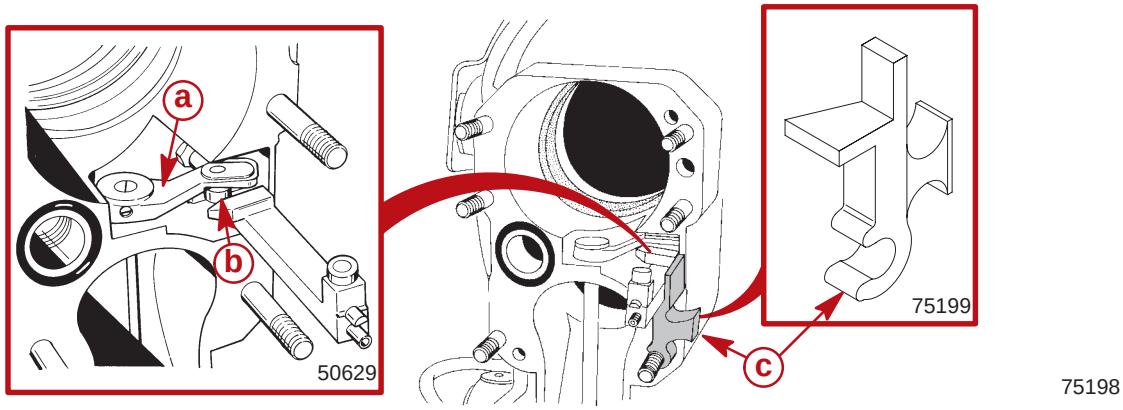


75525

a - Shift Shaft
b - Shift Shaft Coupler
c - Shift Slide

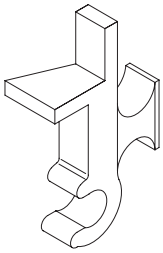
IMPORTANT: Shift slide assembly is free to rotate on core wire; therefore, be careful that shift slide remains in upright position and is properly engaged with shift shaft lever roller while installing drive unit.

11. Engage shift shaft roller into shift shaft lever. Snap the Shift Shaft Slide Stabilizer Tool onto stud directly below shift slide and position as shown.

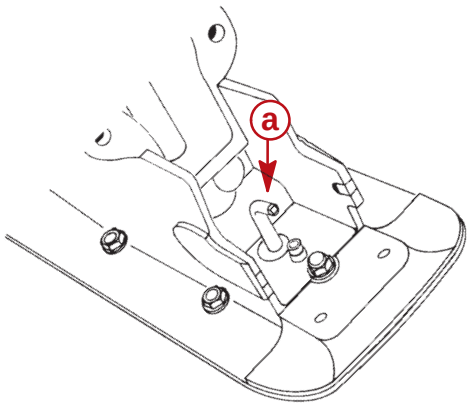


75198

a - Shift Shaft Lever
b - Roller
c - Shift Shaft Slide Stabilizer Tool

Tool / Description	Part Number
Shift Shaft Slide Stabilizer Tool	91-809815A1
Description: Checks alignment of shift shaft slide and sterndrive unit during installation.	 75199

12. Position drive unit shift shaft so that it is straight forward by turning shift shaft clockwise while simultaneously turning propeller shaft counterclockwise.



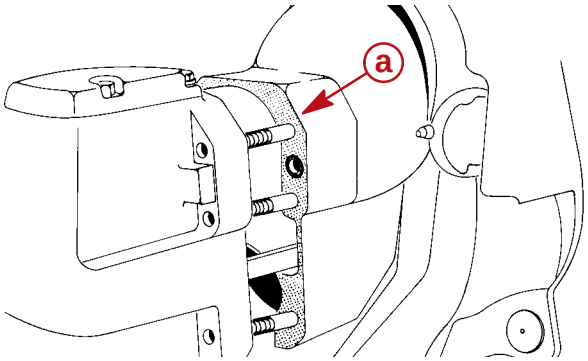
75512

a - Drive Unit Shift Shaft

IMPORTANT: Be sure to install RH or LH drive unit on the appropriate transom assembly when making dual engine installations. The LH rotation drive unit can be identified by the decal on the back side of the upper drive shaft housing, which states:

“Alpha One - Counter Rotation”

13. Place gasket on bell housing.



70010

a - Gasket

14. Install sterndrive unit as follows:

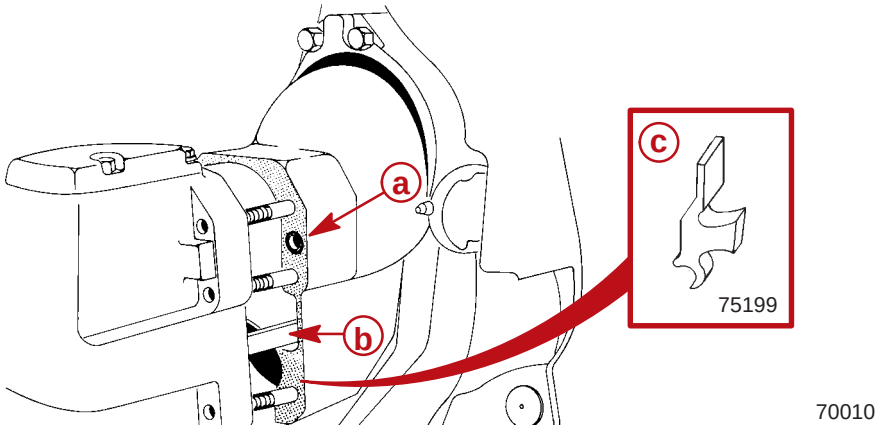
    a. Position trim cylinder straight back (over top of acceleration plate). Be careful not to scratch acceleration plate or trim cylinders.

    b. Guide U-joint shaft through gimbal bearing and into engine coupler while simultaneously guiding shift slide into drive shaft housing. Make sure shift slide remains upright and engaged with bell housing shift shaft lever.

    c. Remove Shift Slide Stabilizer Tool.

    d. Slide drive unit all the way into bell housing.

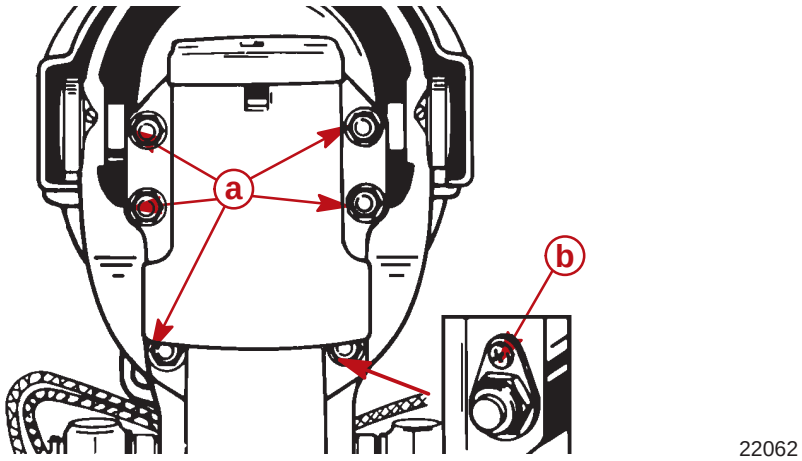
IMPORTANT: If drive unit will not slide all the way into bell housing, ensure that the shift shaft and couplers are positioned properly. Do not force drive unit into position.



a - Gasket
b - Shift Slide
c - Shift Slide Stabilizer Tool

    e. If necessary, rotate propeller shaft **counterclockwise** slightly to help align U-joint shaft splines with engine coupler splines. Then slide drive unit all the way into bell housing.

    f. Secure drive unit to bell housings using fasteners as shown. Torque to 50 lb-ft (68 Nm).



a - Locknut and Flat Washers
b - Locknut and Continuity Circuit Washer (No flat washer at this location)

15. Return remote control shift lever to the neutral position.

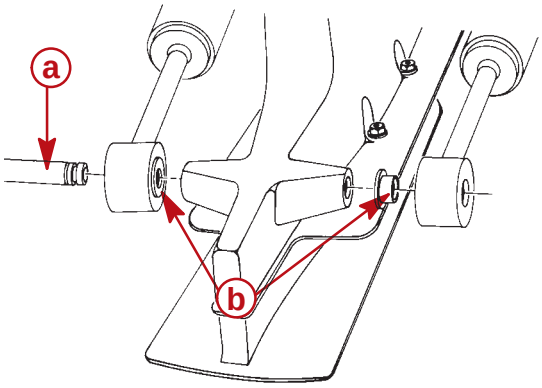
16. Install trim cylinders on aft end of drive unit:

NOTE: *Upon installation of hardware apply Quicksilver 2-4-C Marine Lubricant with Teflon to all components except plastic caps.*

a. Insert one bushing in each inboard hole of both trim cylinders.

b. Align the bores of trim cylinders with that of the drive unit.

c. Insert the aft anchor pin through the port trim cylinder, drive unit bore and starboard trim cylinder until it protrudes equally.



70026

a - Aft Anchor Pin
b - Bushings

NOTE: *Distance between trim cylinders and drive unit anchor pin bore is exaggerated for visual clarity.*

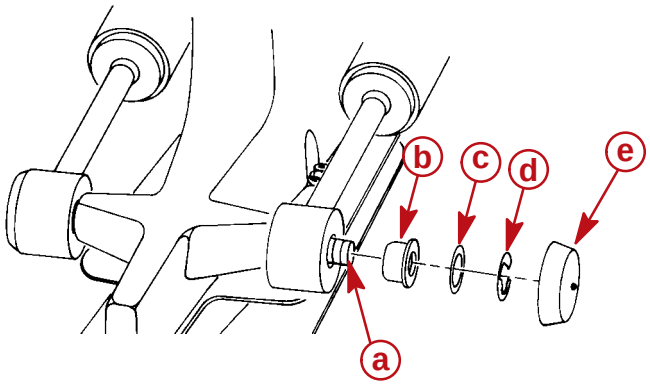
d. Install the two remaining bushings onto the aft anchor pin ends and fit into bore of trim cylinders.

e. Install the flat washers.

f. Install the E-ring clips into narrow grooves.

NOTE: *The inboard grooves of the aft anchor pin are for E-ring clips, and wider, outboard grooves are for securing plastic caps.*

g. Push plastic caps onto ends of aft anchor pin.



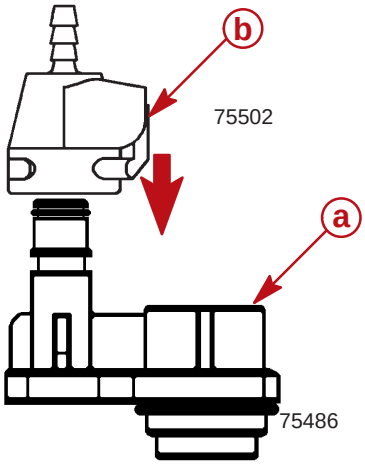
70027

a - Aft Anchor Pin
b - Bushings
c - Flat Washers
d - E-Ring Clips
e - Plastic Caps

17. Place drive unit serial number decal as described in “General Information.”

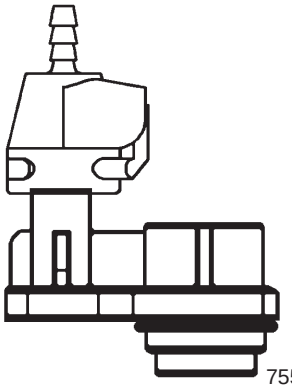
ATTACHING SPEEDOMETER WATER TUBE - GIMBAL HOUSING TO ALPHA STERNDRIVE

1. Raise drive to gain access to area between gimbal housing and sterndrive, immediately above the transom end of the anti-ventilation plate.
2. Align plastic slots on male and female portions and insert.
3. Push down to secure.

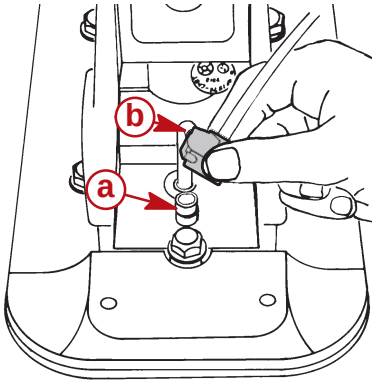


75502

75486


75508

a - Male End of Speedometer Tube Fitting
b - Female Portion



75513

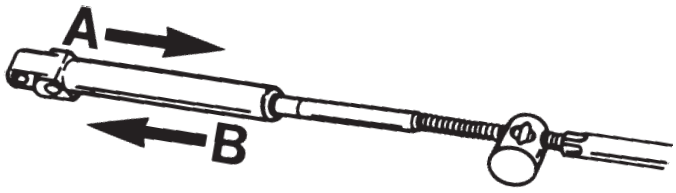
a - Tube Fitting, Male End
b - Topside Portion, Female End

Alpha Drive Unit Remote Control and Drive Unit Shift Cables Adjustment, Drive Unit Installed

IMPORTANT: Shift cable adjustment for a right hand (RH) rotation drive unit is different than the procedure for adjusting a left hand (LH) rotation drive unit. Be sure to refer to the appropriate procedure when performing the following steps.

RIGHT HAND ROTATION - Install control cable in remote control so that cable end will move in direction “A” when shift handle is placed in the forward position.

LEFT HAND ROTATION - Install the control cable in remote control so that cable end will move in direction “B” when shift handle is placed in the forward position.

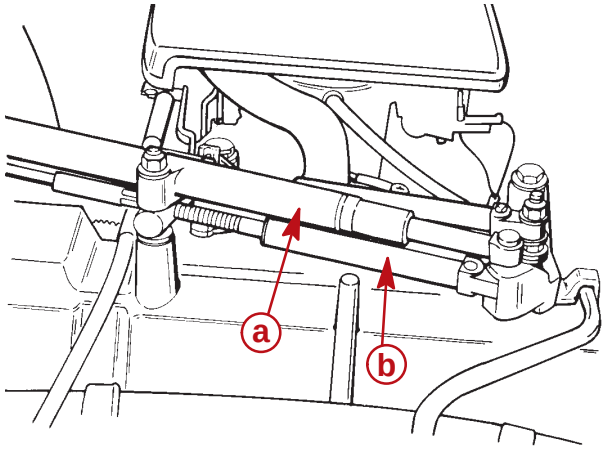


23242

IMPORTANT: Drive unit must be installed.

IMPORTANT: DO NOT run engine.

NOTE: *The illustrations on the following pages show models that have a shift plate that is mounted on the exhaust elbow. The shift mechanism components on the 3.0L model are located on the top of the valve cover as shown in the following illustration. The procedure for making the adjustments is exactly the same.*

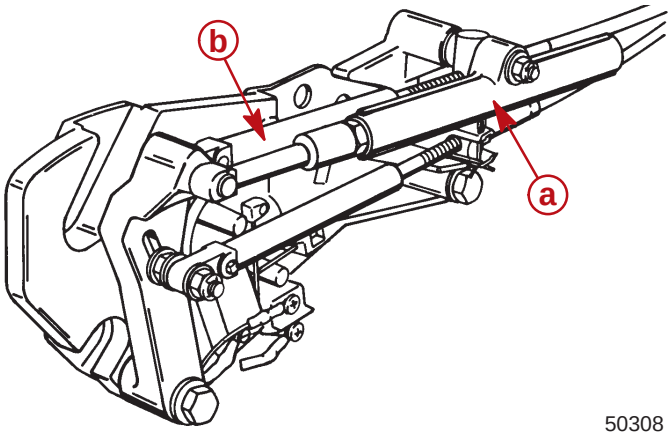


50626

3.0L Model With Components Mounted On Valve Cover

a - Shift Assist Assembly
b - Remote Control Shift Cable

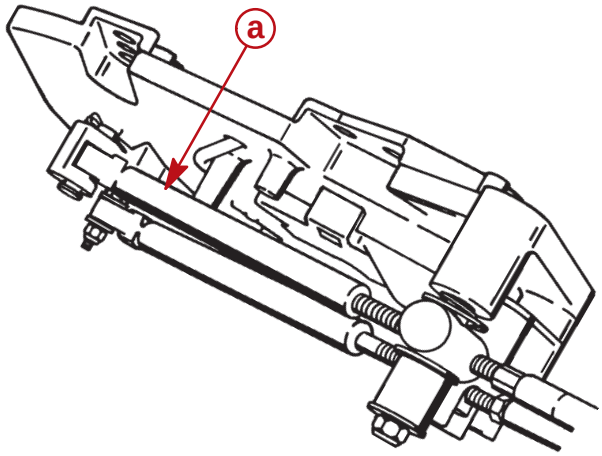
1. Remove remote control shift cable and shift assist assembly (if installed).



50308

With Shift Assist Assembly

a - Shift Assist Assembly
b - Remote Control Shift Cable



50310

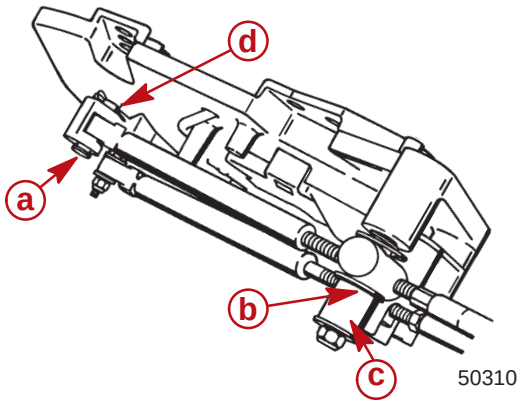
Without Shift Assist Assembly

a - Remote Control Shift Cable

IMPORTANT: If boat is being equipped with a REMOTE CONTROL THAT HAS SEPARATE SHIFT AND THROTTLE LEVERS, the shift assist assembly that is shipped with the engine should NOT be used. The use of the shift assist assembly with this type of remote control can cause the shift lever to move out of gear unexpectedly.

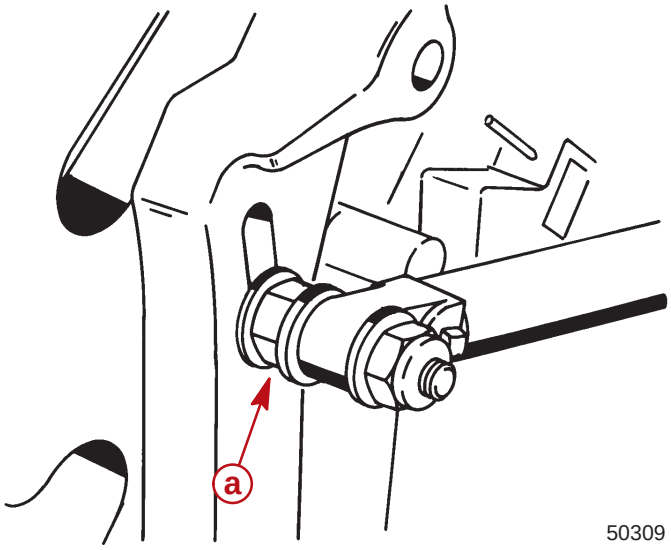
The following kit will have to be ordered to connect remote control shift cable when shift assist assembly is not used.

Spacer Kit 23-11284A1



a - Clevis Pin
b - Washer
c - Spacer
d - Cotter Pin

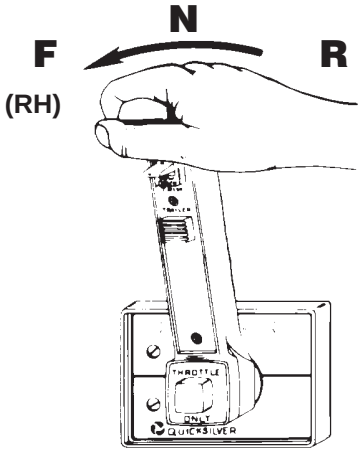
2. Ensure shift lever adjustable stud is at bottom of slot. If necessary, loosen stud and move it to end of slot toward pivot point and retighten stud.



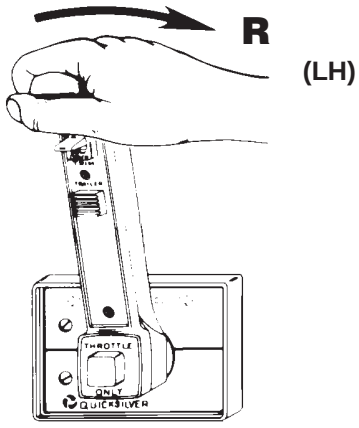
a - Adjustable Stud

3. Shift remote control as stated in “a” or “b” following:

   a. **Right Hand (RH) Rotation Drive Unit -** forward gear, past detent, into wide-open-throttle position.

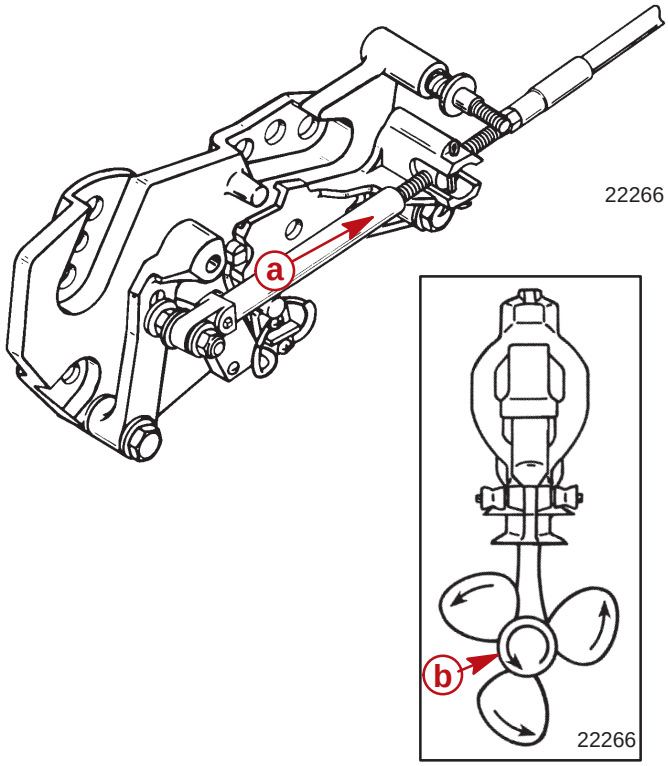


   b. **Left Hand (LH) Rotation Drive Unit -** reverse gear, past detent, into wide-open-throttle position.



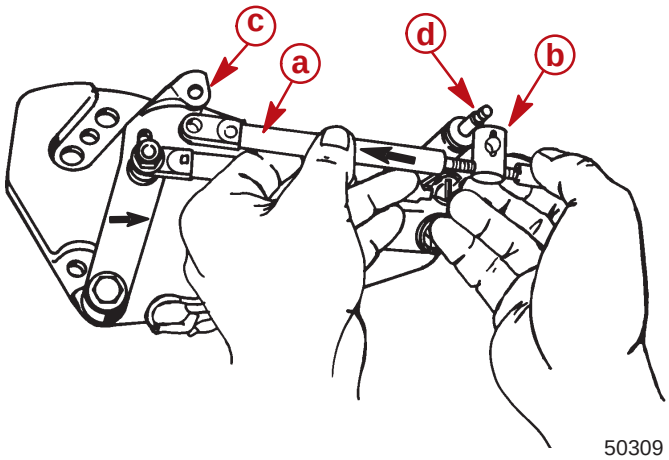
4. Place drive unit into gear by pushing in on drive unit shift cable, while simultaneously rotating propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement. Maintain a light pressure on the drive unit shift cable to hold it at the end of its travel (this removes all slack from the cable).

   IMPORTANT: Do not use excessive force when holding pressure on the drive unit shift cable. Excessive force would be indicated by movement of the shift cutout switch.



a - Drive Unit Shift Cable - Push In
b - Propeller Shaft - Rotate Counterclockwise

5. Lightly pull on remote control shift cable end guide (to remove slack from remote control and cable) and adjust brass barrel as necessary to align attaching points with shift lever clevis pin hole and stud. Be sure to maintain light pressure on drive unit shift cable.



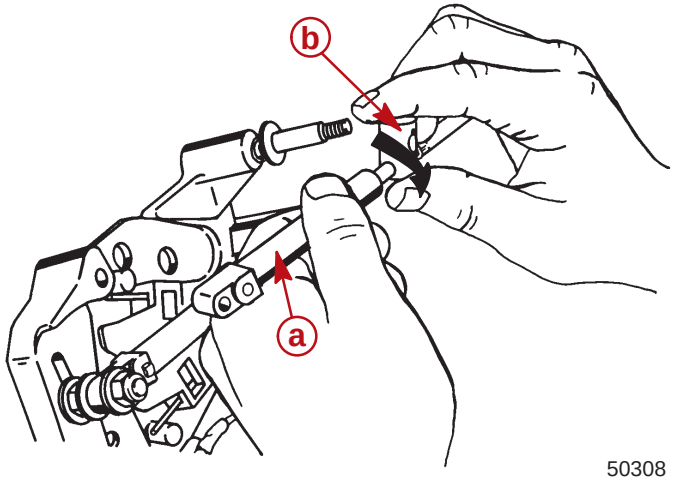
a - End Guide
b - Brass Barrel
c - Shift Lever Clevis Pin Hole
d - Stud

6. If the shift plate is equipped with a Shift Assist Assembly then skip this step and go to step 7.

   If the shift plate does not have a Shift Assist Assembly then follow these isntructions

   NOTE: *Two different size threaded ends have been used on the remote control shift cable.*

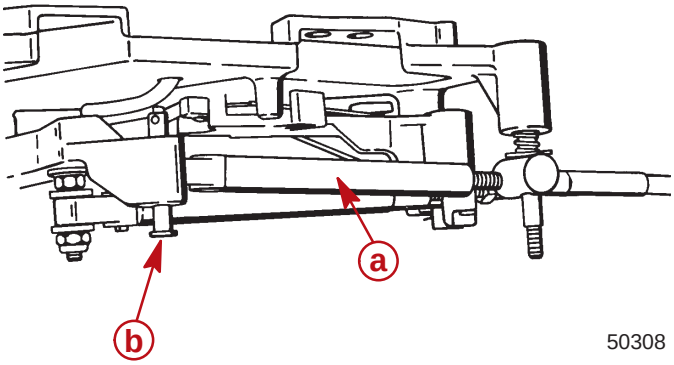
   After cable has been aligned, turn brass barrel 2 turns **away** from cable end guide on 1/4-28 threaded ends and 4 turns away from cable end guide on 1/4-40 threaded ends.



50308

a - End Guide
b - Brass Barrel

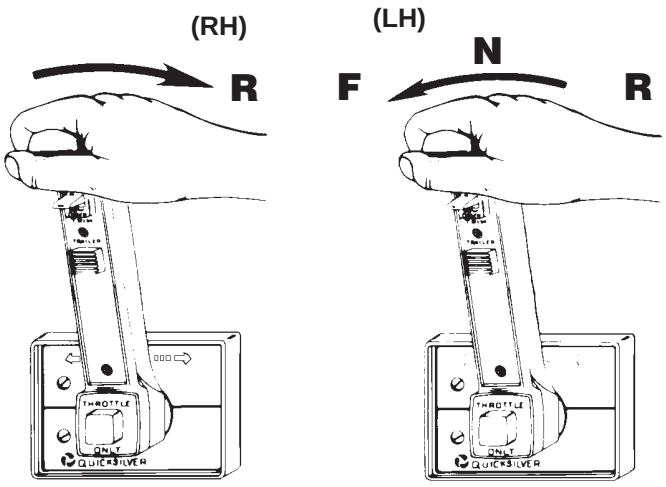
7. Temporarily install remote control shift cable on stud and install clevis pin.



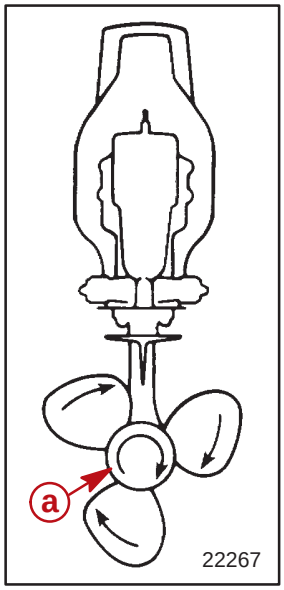
50308

a - Remote Control Shift Cable
b - Clevis Pin

8. Shift remote control as stated in “a” or “b” following:
   a. **Right Hand (RH) Rotation Drive Unit -** reverse gear, past detent, into wide-open-throttle position.
   b. **Left Hand (LH) Rotation Drive Unit -** forward gear, past detent, into wide-open-throttle position.



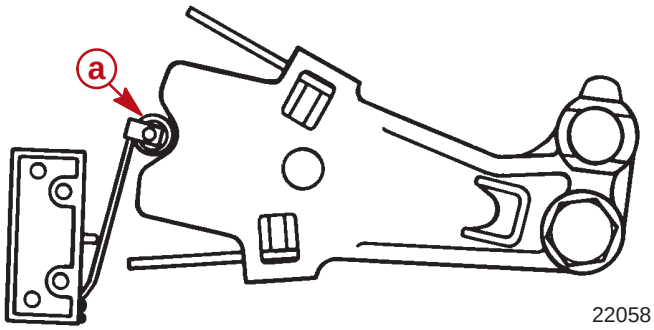
Simultaneously rotate propeller shaft clockwise until shaft stops to ensure full clutch engagement.



a - Propeller Shaft - Rotate Clockwise

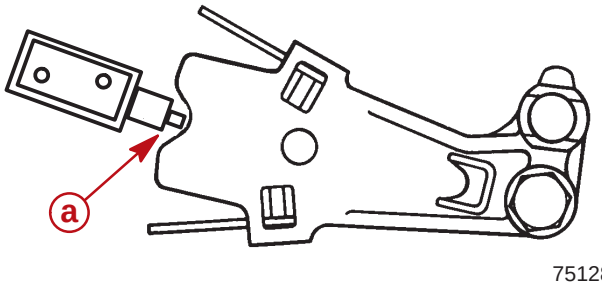
9. Perform “a” or “b” as appropriate:

   a. **On Models with Earlier Type Switch:** check shift cutout switch lever position. Roller must be centered.



a - Shift Cutout Switch Roller

   b. **On Models with Later Type Switch:** check shift cutout switch plunger position. Pin must be centered.



a - Shift Cutout Switch Plunger Pin

10. If roller or plunger pin is not centered:

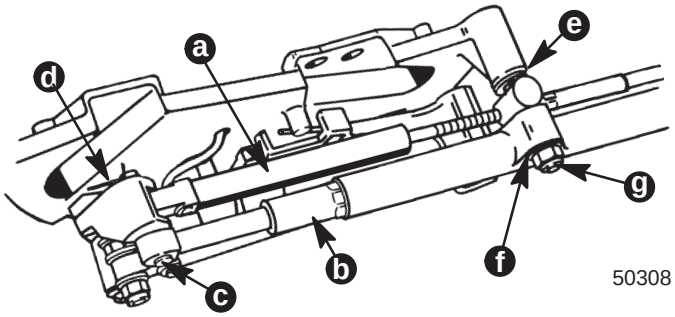
   a. Ensure adjustable stud is at bottom of slot in shift lever.

   b. Check remote control for proper shift cable output [3 in. (76mm) ± 1/8 in. (3mm)]. Refer to “Installation Requirements.”

   c. If “a” and “b” are correct, ensure drive unit shift cable is not crushed or kinked. (If drive unit shift cable is binding, the shift cutout switch roller or plunger pin will move off center when shifting “into” and “out of” forward **and** reverse).

NOTE: *If shift cable was damaged during installation, install new shift cable assembly in accordance with instructions contained in sterndrive service manual, then repeat shift cable adjustment procedure.*

11. After remote control shift cable has been properly adjusted, reinstall cable and shift assist assembly (if applicable) and secure with hardware as shown.

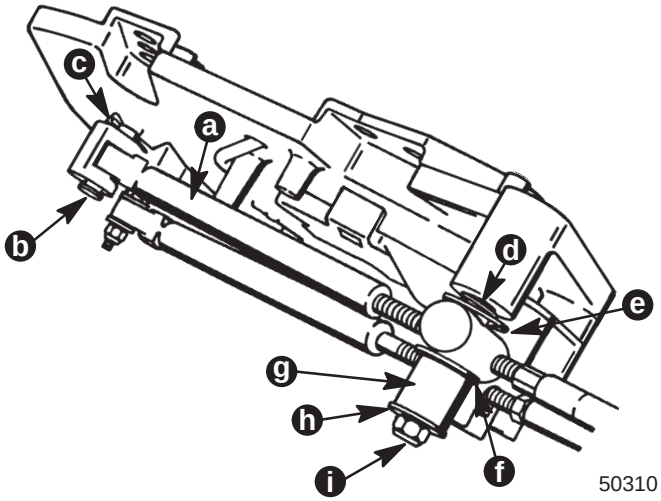


With Shift Assist Assembly

- **a** - Remote Control Shift Cable
- **b** - Shift Assist Assembly
- **c** - Clevis Pin
- **d** - Cotter Pin (Spread Both Prongs)
- **e** - Large I.D. Washer
- **f** - Small I.D. Washer
- **g** - Locknut (Tighten Until Bottomed, Then Back Off 1/2 Turn)

There should be no pressure on either side of the shift assist assembly attaching point. Failure to adjust properly could apply excessive load to the cable and cause the throttle only portion of the control to hang up and malfunction.

If the shift assist assembly requires effort to fit over the anchor stud and clevis pin, the shift cable from the control box is adjusted incorrectly. Remove the shift cable and reposition the adjustment barrel as required to allow the shift assist assembly to be attached with no effort.



Without Shift Assist Assembly

- **a** - Remote Control Shift Cable
- **b** - Pin
- **c** - Cotter Pin (Existing)
- **d** - Spring (Existing)
- **e** - Washer (Existing)
- **f** - Washer
- **g** - Spacer
- **h** - Washer (Existing)
- **i** - Locknut (Existing) - (Tighten Until Bottomed, Then Back Off 1/2 Turn)

IMPORTANT: If an extra long remote control shift cable is used, or if there are a large number of bends in remote control shift cable, or remote control has inadequate output travel, an additional adjustment may be necessary. Refer to step 12 or 13 as applicable.

12. **Remote Control with Single Lever Shift/Throttle Control:**

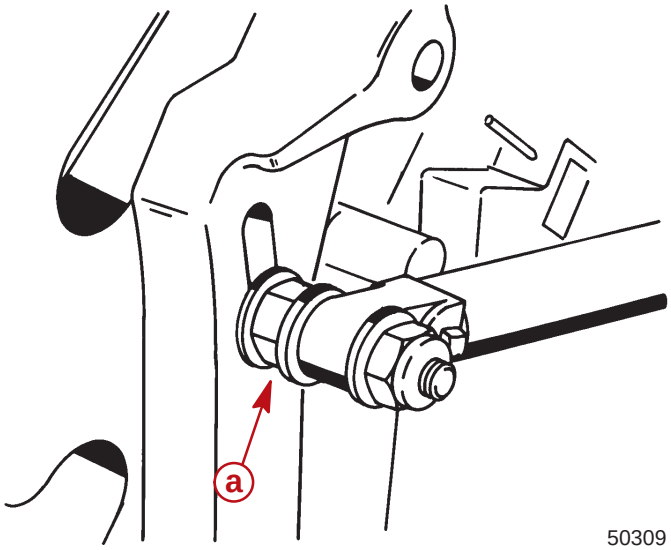
    a. **RIGHT HAND (RH) propeller rotation drive unit -** Shift remote control into reverse gear, wide-open-throttle position while simultaneously rotating propeller shaft clockwise. Clutch should engage and cause propeller shaft to lock. If clutch does not engage, loosen adjustable stud on shift lever and move it upward in slot until clutch engages with reverse gear. Retighten stud. Shift remote control several times and stop in reverse to recheck shift cutout switch position. Roller, or plunger pin, must be centered.

    b. **LEFT HAND (LH) propeller rotation drive unit -** Shift remote control into forward gear, wide-open-throttle position while simultaneously rotating propeller shaft clockwise. Clutch should engage and cause propeller shaft to lock. If clutch does not engage, loosen adjustable stud on shift lever and move it upward in slot until clutch engages with forward gear. Retighten stud. Shift remote control several times and stop in forward to recheck shift cutout switch position. Roller, or plunger pin, must be centered.

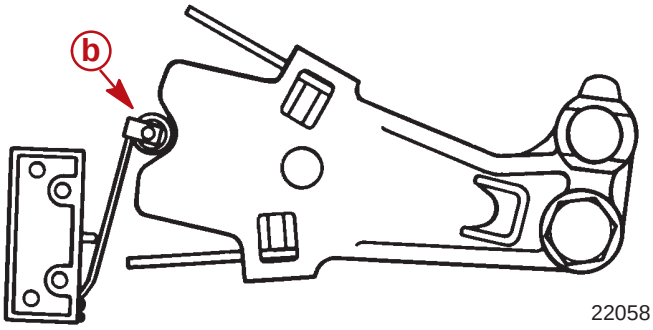
13. **Two Lever Remote Control with Separate Shift and Throttle Levers:**

    a. **RIGHT HAND (RH) propeller rotation drive unit -** While turning propeller shaft clockwise, move remote control shift handle into full reverse position. Clutch should engage before shift lever comes to a stop. If clutch does not engage, loosen adjustable stud on shift lever and move it upward in slot until clutch engages with reverse gear. Retighten stud. Shift remote control several times and stop in reverse to recheck shift cutout switch position. Roller, or plunger pin, must be centered.

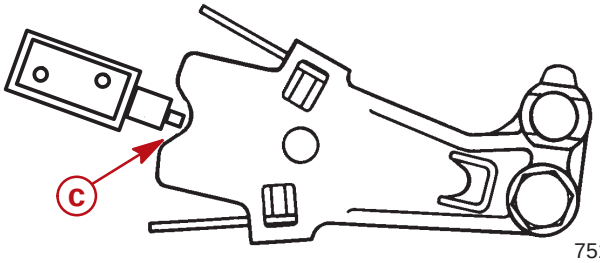
    b. **LEFT HAND (LH) propeller rotation drive unit -** While turning propeller shaft clockwise, move remote control shift handle into full forward position. Clutch should engage before shift lever comes to a stop. If clutch does not engage, loosen adjustable stud on shift lever and move it upward in slot until clutch engages with forward gear. Retighten stud. Shift remote control several times and stop in forward to recheck shift cutout switch position. Roller, or plunger pin, must be centered.



50309



22058



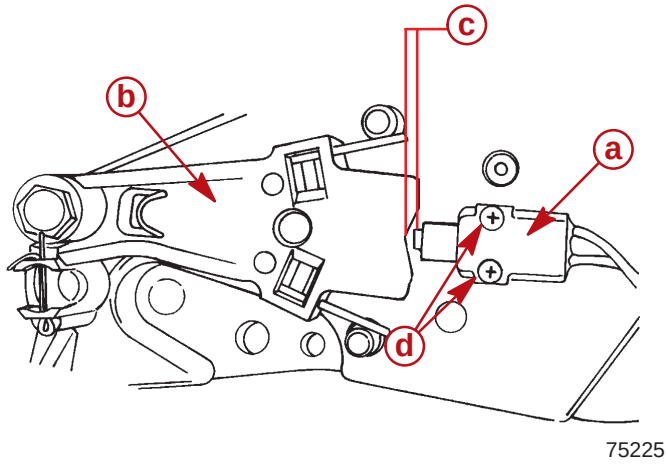
75128

a - Adjustable Stud
b - Shift Cutout Switch Roller
c - Shift Cutout Switch Plunger Pin

Alpha Models - Shift Cutout Switch

Checking Cutout Switch Timing (Models with Plunger Type Switch)

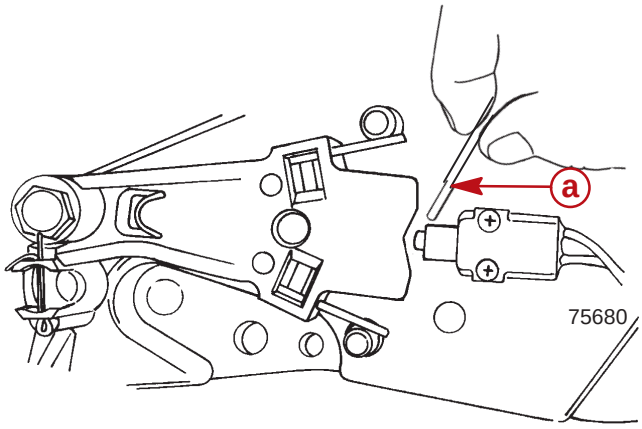
1. While holding the retainer nuts on the back of the shift plate, loosen the two phillips head screws on the shift cutout switch and slowly move the switch either forward or aft.



75225

a - Switch/Plunger Pin
b - Activating Lever Assembly
c - 1/32” Adjustment
d - Two Screws

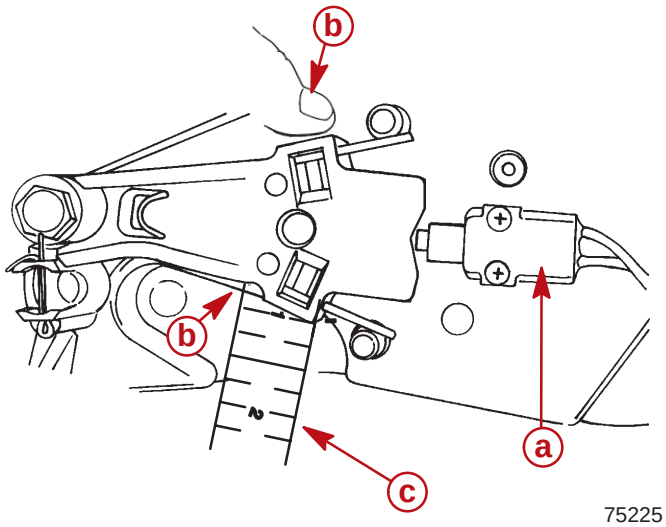
2. Adjust switch to locate plunger pin to 1/32 in. between plunger pin and activating lever assembly.



75679

a - 1/32 in. Drill Bit

3. Slowly move activating lever assembly off until cutout switch opens or closes. Circuit should open or close when the activating lever assembly is moved 3/16 in. (+ or – 1/32 in.). Measure with 6 in. steel rule.



75225

a - Cutout Switch
b - Movement of Activating Lever Assembly
c - 6 in. Steel Rule

4. After adjustments are made and are within 3/16 in. (+ or – 1/32 in.), tighten the screws on the cutout switch. After tightening screws, recheck the plunger pin position.

Checking Operation

1. Reconnect throttle cable(s), removed earlier.
2. Place boat in water and start engine. Check the following:
   a. Shift into forward and reverse gear, making sure that clutch engages before engine begins to accelerate.
   b. Accelerate engine in forward and reverse gear to ensure engine does not shut down.
   c. Check that shift cutout switch plunger is centered in notch of shift cutout lever, with drive unit in forward and reverse gear.
   d. Shifting from IN gear position to neutral, ensure drive unit is in neutral before remote control shift lever comes to neutral detent position.

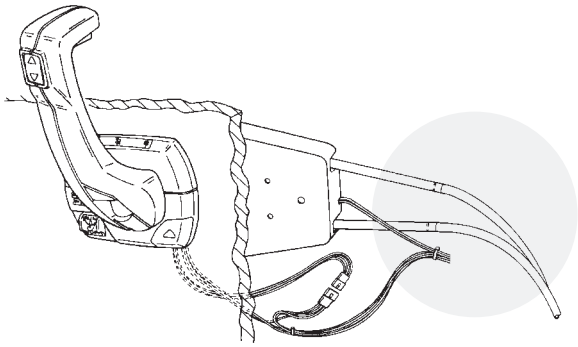
Troubleshooting Shift Problems

(Information from MC Service Bulletin 96-5, Rev. Nov. 1999.)

NOTE: *The following information is provided to assist an installer in troubleshooting if hard shifting or chucking/racheting is encountered when shifting into forward gear.*

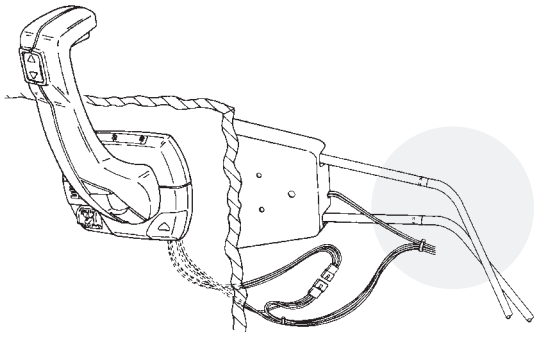
1. When installing the control box in the side panel of the boat, make sure that the cables have enough clearance to operate. This is necessary because the cables move up and down when the shift handle is moved. If the control box is mounted too far back toward any fiberglass structure, the cables will be interfered with; this will cause very hard shifting.

   NOTE: *The control box housing can be rotated in 30° increments to improve cable routing.*



74688

Proper Cable Bend

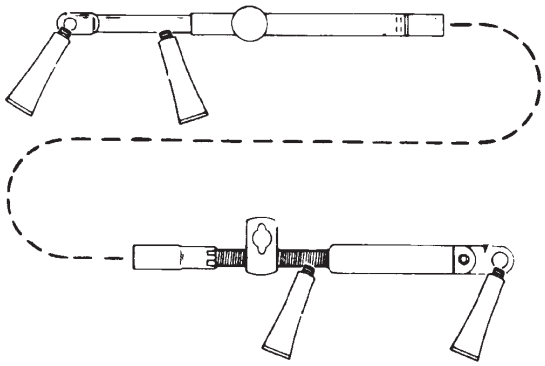


74689

Improper Cable Bend

2. Make sure that when the shift cable from the control box is led through the side gunnel of the hull, it does not have any extremely sharp bends in it as this will cause stiff shifting.

3. Before installing the shift cable into the control box, extend the stainless rod eye end of the cable and grease it with 2-4-C Marine Lubricant with Teflon. Move it back and forth to allow even distribution of the grease.



22005

4. Do not strap or clamp the control cables to any other cables or rigid structure within **3 ft. (914 mm)** of the control box.
5. Be sure the cable is not permanently kinked.
6. Make sure there is proper clearance for cable movement when the control box is installed in the side panel. The cables must have room to move up and down when the control handle is shifted into either forward or reverse.
7. Ensure that the engine was not set down on the intermediate shift cable during installation, as this will crush the inner cable tubing and cause improper and / or stiff shifting.
8. DO NOT fasten the shift cable with straps or clamps to any other cable within **5 ft. (1.5 m)** of the shift plate.
9. DO NOT fasten the shift cable to the transom with any type of plastic clips or fasteners within **5 ft. (1.5 m)** of the shift plate.
10. DO NOT overtighten the throttle or shift cable attaching nuts at the engine end. Barrel and cable end must be free to rotate on the mounting stud.

    NOTE: *Lubricate attaching points with motor oil.*

11. Check the intermediate shift cable routing from the transom assembly to the shift plate as follows:

    a. The cable should come through the transom, above the exhaust pipe and make a turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing.

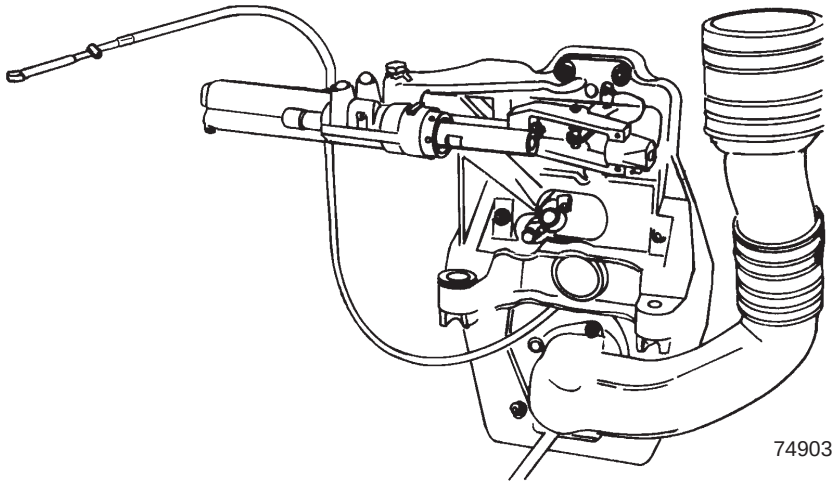
    b. The cable should then be routed under the starboard rear engine mount and turn toward the transom.

    c. The cable should then go up behind the power steering valve and loop over to the shift plate on the engine, where it is connected to the anchor points on the shift plate.

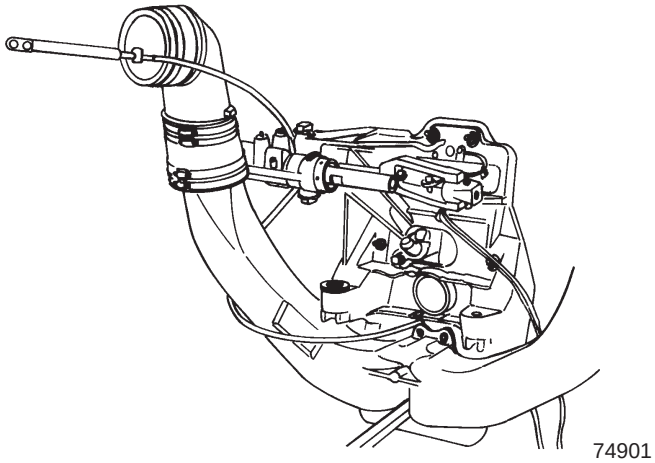
    Following this routing will prevent the engine coupler from damaging the cable.

    NOTE: *A final check of the adjustments should be made with the boat in the water and engine running. This should be done as part of the pre-delivery inspection.*

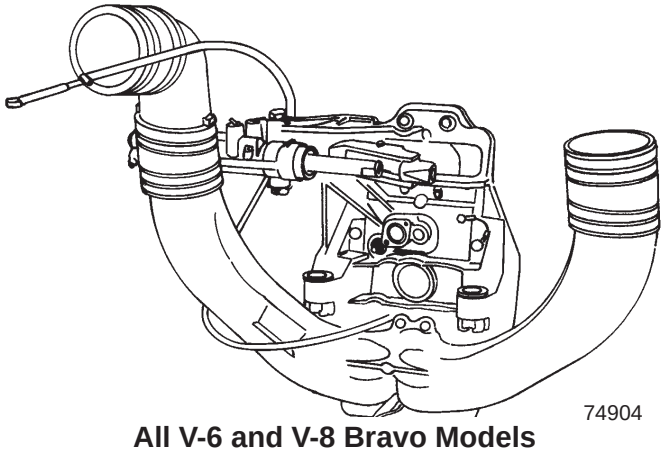
Shift Cable Routing



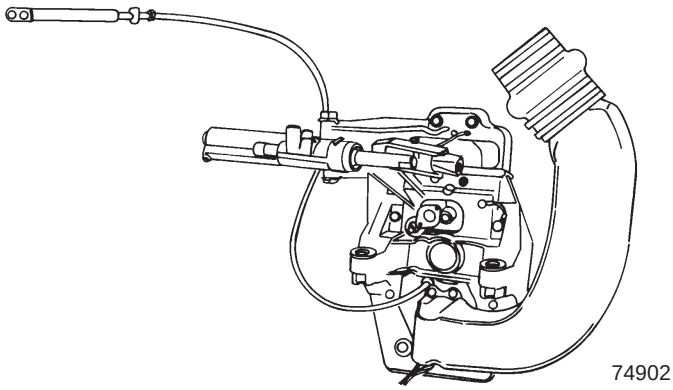
3.0L & 3.0LX Model Only



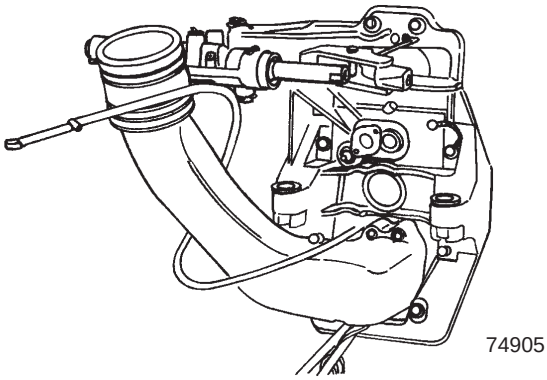
All V-6 and V-8 Alpha Models



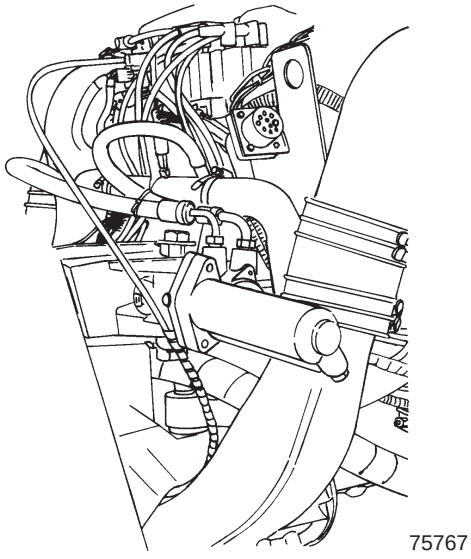
All V-6 and V-8 Bravo Models (except 7.4L [L-29] MPI)



V8 Diesel Model



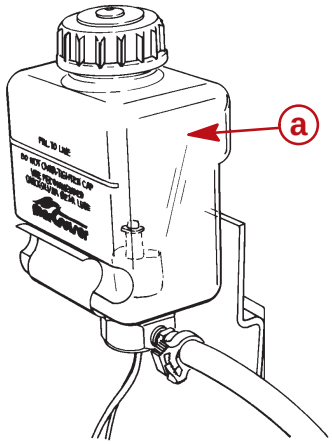
In-Line Diesel Model



On 7.4L MPI MCM

Bravo Sterndrive Unit Installation

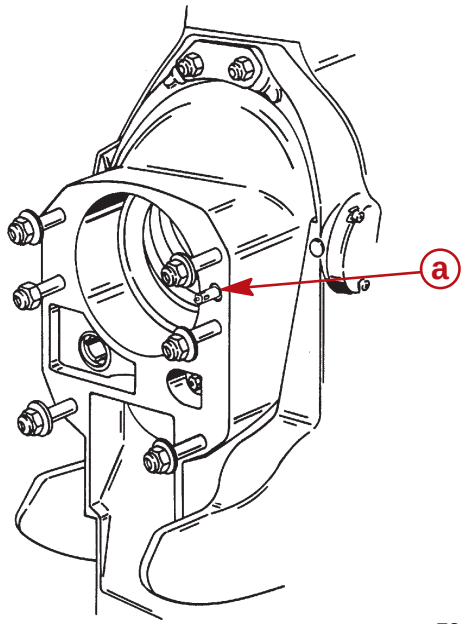
1. Remove trim cylinders' support and dust cover from bell housing studs. (Retain elastic stop nuts and flat washers.)
2. Remove monitor cap and fill gear lube monitor with Hi-Performance Gear Lube.



71995

a - Gear Lube Monitor

3. Push in on dribble valve until gear lube appears. Once gear lube appears, release dribble valve.

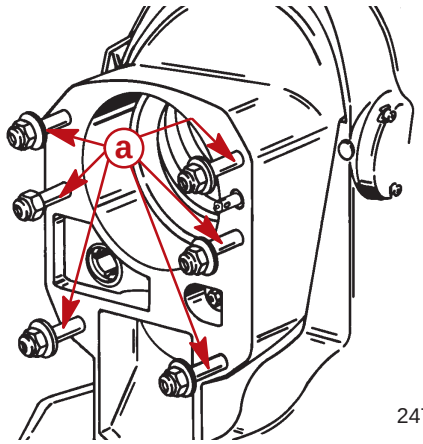


72471

a - Dribble Valve

4. Fill monitor to FILL mark and replace monitor cap.

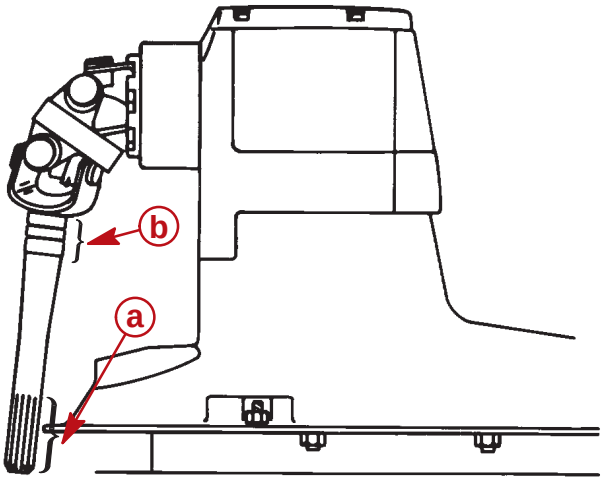
5. Coat studs with Quicksilver Engine Coupler Spline Grease.



24725

a - Studs

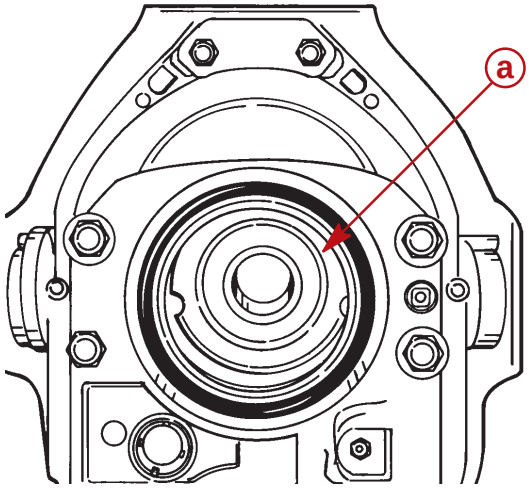
6. Lubricate U-joint shaft splines and U-joint shaft O-rings with Quicksilver Engine Coupler Spline Grease.



22026

a - Splines
b - O-rings

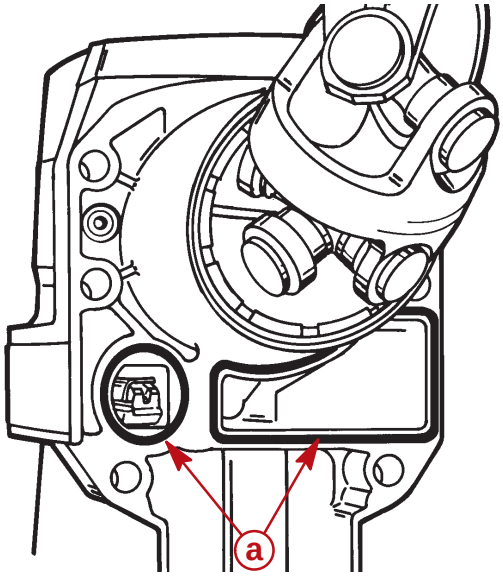
7. Check to ensure that driveshaft bellows is clean and free of debris.



24725

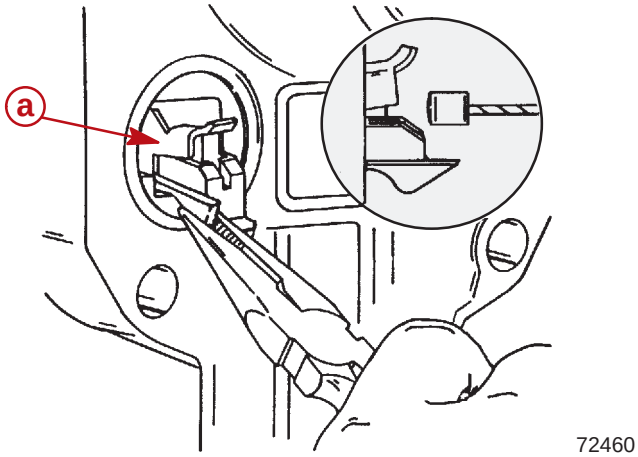
a - Driveshaft Bellows

8. Lubricate O-ring seals with 2-4-C W/Teflon Marine Lubricant.



a - O-ring Seals

9. Pull out shift linkage as far as it moves. “Jaws” will open, as shown.

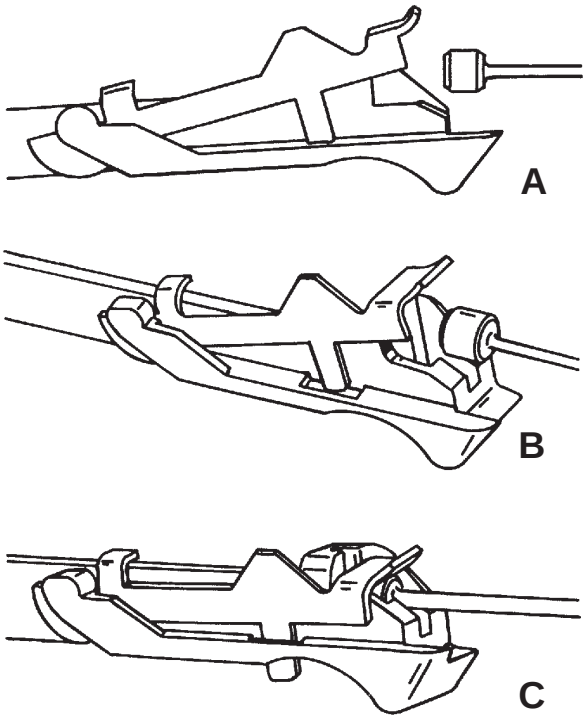


a - Shift Linkage

IMPORTANT: As stern drive is inserted into drive unit, entry of the bell housing shift cable must be closely checked to make sure cable enters the “Jaws” of shift linkage assembly in the stern drive.

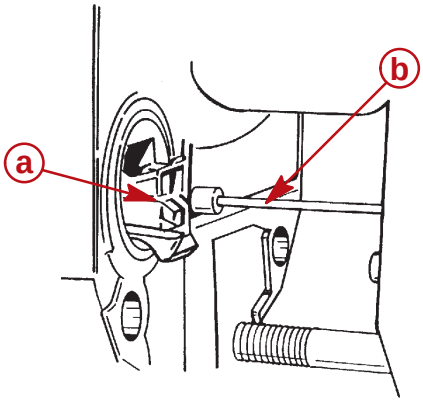
10. Place Remote Control in neutral position.

NOTE: *As Bell Housing shift cable enters the shift linkage assembly, it pushes the assembly back into the stern drive housing, and the "Jaw" closes, securing the cable, as shown in Steps "A," "B," and "C."*



72467

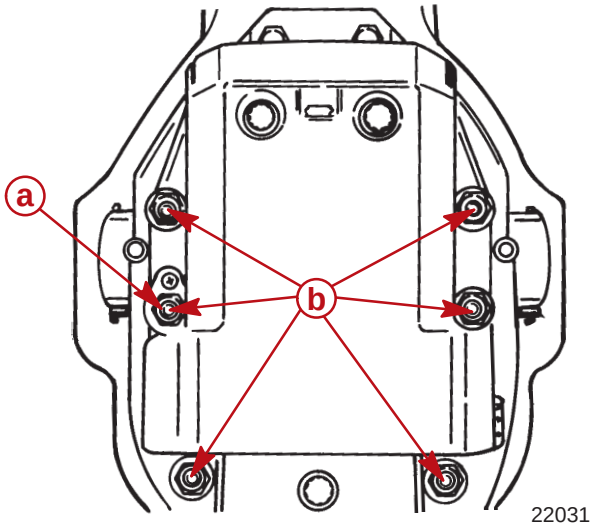
IMPORTANT: If Bell Housing Shift Cable (b) does not line up to properly enter "Jaws" of shift linkage assembly (a), cable will have to be aligned manually.



72457

11. Place drive shaft housing in position on bell housing and install drive unit, as follows:
    a. Position trim cylinders so they point straight backwards.
    b. Position drive unit so that universal joint shaft aligns with bell housing bore.
    c. Guide U-joint shaft thru bearing in gimbal housing and into engine coupler. Make sure that shift linkage "Jaws" engage the bell housing shift cable assembly.
    d. If necessary, rotate propeller shaft counterclockwise slightly (using a propeller) to align U-joint shaft splines with splines in engine coupling, then slide drive unit ail-the-way into bell housing.

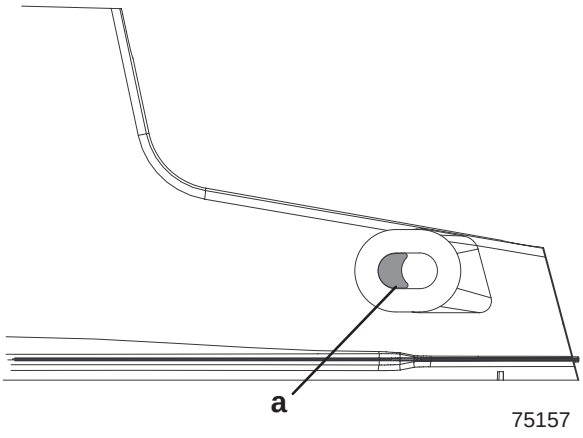
12. Secure drive unit to bell housing with 5 flat washers and 6 locknuts. Torque to 50 lb. ft. (68 N·m).

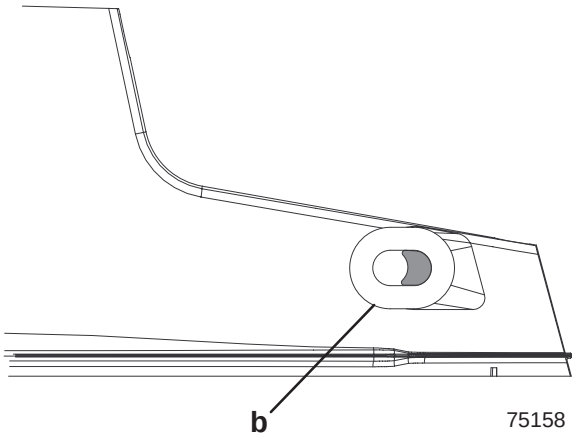


a - Continuity Washer - Do Not Install Flat Washer Here
b - Elastic Stop Nuts (6) and Flat Washers (5)

IMPORTANT: <u>On Bravo drives,</u> the "Trim-In Limit Pin" must be properly positioned before installing the trim cylinder anchor pin in the following steps.

13. Ensure that the Trim-In Limit Pin is positioned as shown for Bravo 1, 2, and 3 models.

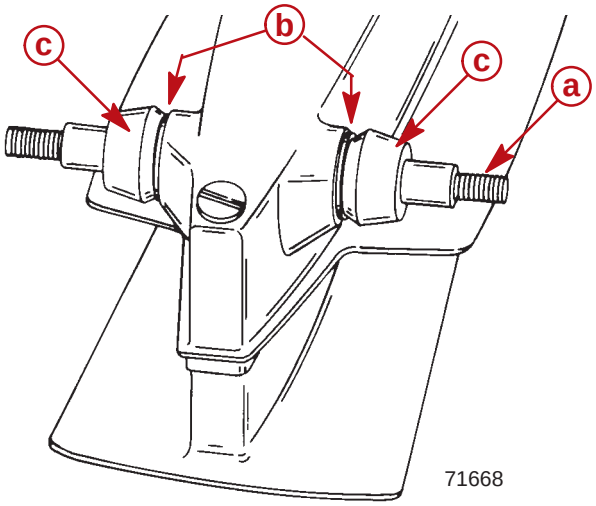




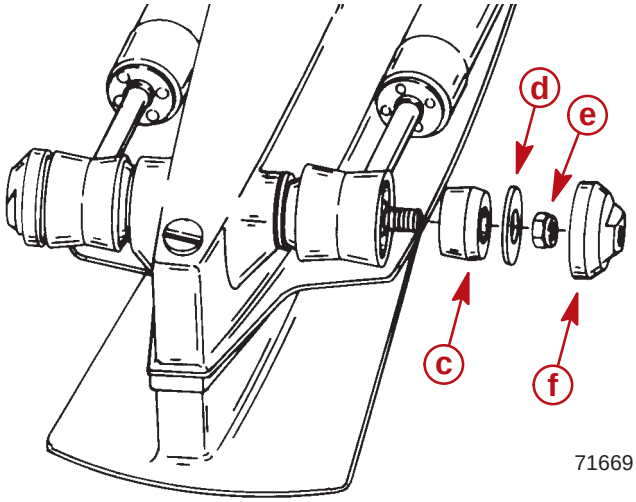
a - Spacer Positioned Forward (Bravo One and Two)
b - Spacer Positioned Aft (Bravo Three)

IMPORTANT: To aid in installing rubber bushings, use a water and soap solution. DO NOT use oil or grease.

14. Install trim cylinders on aft end of drive unit with hardware as shown. Coat anchor pin threads with 2-4-C W/Teflon Marine Lubricant and tighten nuts until they bottom. Install plastic caps and tighten hand tight only.



71668



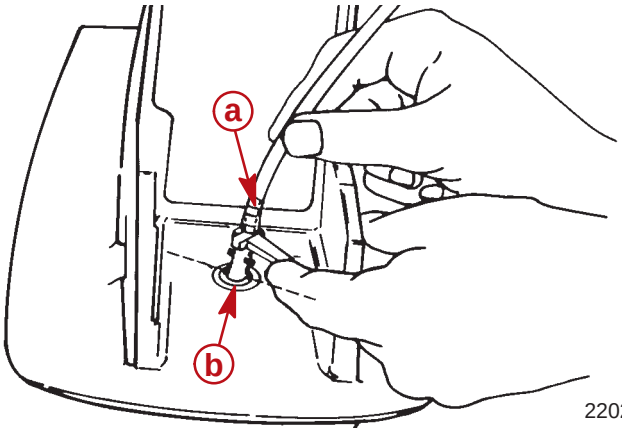
71669

- **a** - Aft Anchor Pin
- **b** - Large I.D. Flat Washers (2)
- **c** - Rubber Bushings (4)
- **d** - Small I.D. Flat Washers (2)
- **e** - Locknuts (2)
- **f** - Plastic Caps (2)

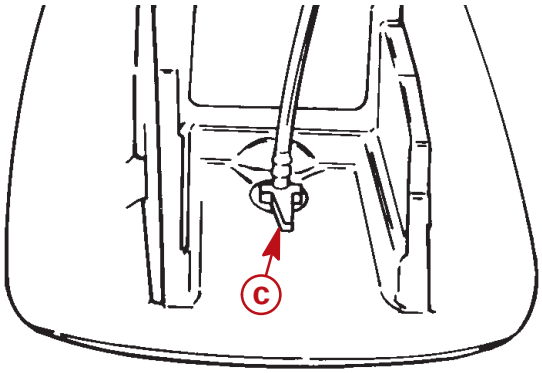
15. Place drive unit serial number decal as described in “General Information”.

ATTACHING SPEEDOMETER WATER TUBE-GIMBAL HOUSING TO STERN DRIVE

1. Raise drive to gain access to area between Gimbal Housing and Stern Drive, immediately atop the transom end of the anti-ventilation plate.
2. Insert speedometer tube fitting into opening on top-side of anti-ventilation plate, in position shown.
3. With fitting fully seated, turn handle to left to a tightly seated position, as shown.



22025

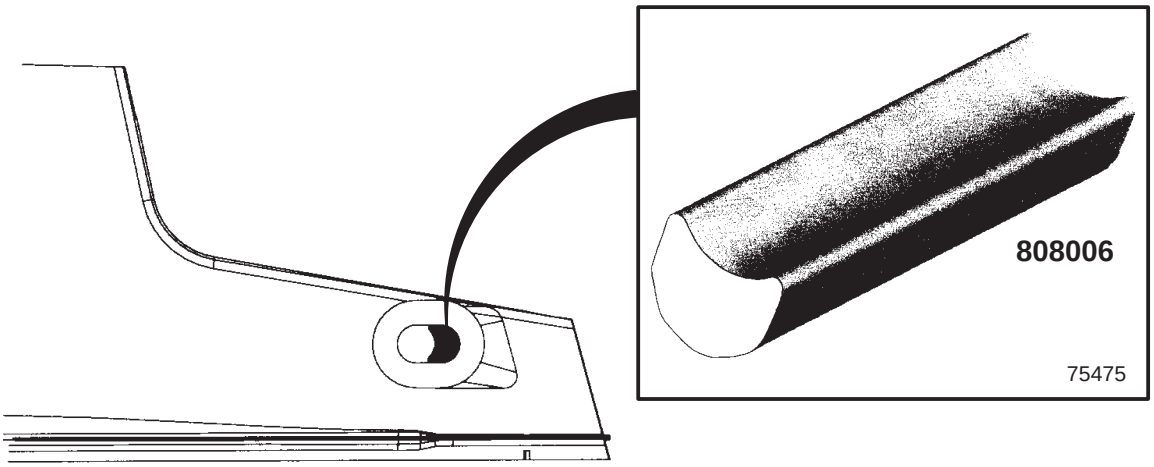


22025

- **a** - Tube Fitting
- **b** - Opening
- **c** - Handle

Drive Shaft Housing, Aft Trim Cylinder Anchor Pin Hole Modified

There was a change made to Bravo drives (S/N 0K184626 and above) and transom assemblies (S/N 0K139943 and above) in late 1997. The Bravo drive shaft housing was changed in the aft trim cylinder anchor pin hole area. It is now slotted to allow for two possible placement positions for a new “trim-in limit” spacer (P/N 808006). The trim in limit spacer is made of a composite material, designed to withstand both the effects of thrust and corrosion. It can be installed by hand. This change replaced the “A-B” trim-in limit blocks that were mounted on the gimbal housing trim cylinder front anchor pin, for most applications.

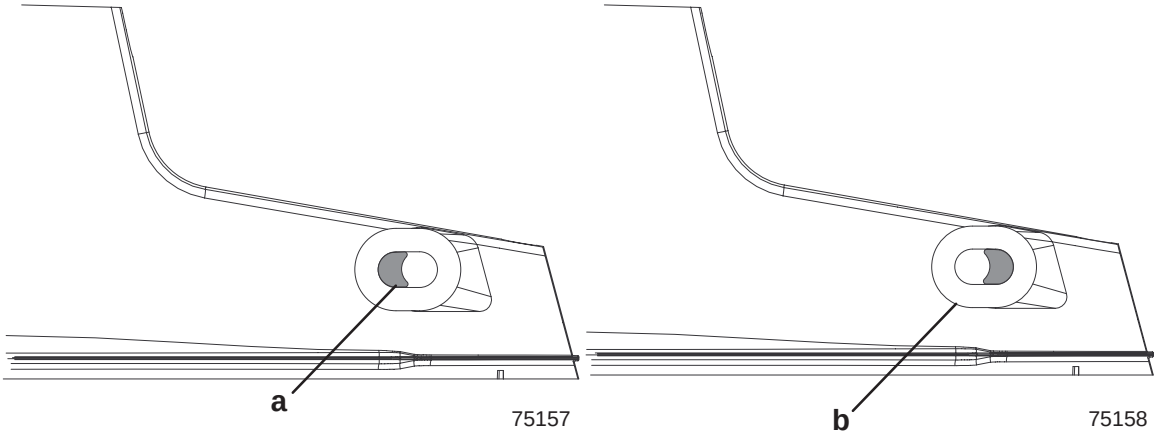


Trim-In Limit Spacer Positioning

When installing a newer 1997 Bravo Three drive unit onto an older, or newer transom assembly you would place the trim-in limit spacer in the aft most position of the rear anchor pin slot. Do not use trim-in limit blocks with this application. You should also install a Trim Limit Spacer Kit in the trim cylinders (P/N 15768A 3). This will prevent the drive from contacting the transom assembly when in the full trailer position.

When you are mounting a newer 1997 Bravo One, or Two drive unit onto a newer transom assembly you should place the trim-in limit spacer in the forward location of the rear anchor pin slot.

See Service Bulletin #98-16 for more information about these changes and trim component positioning.



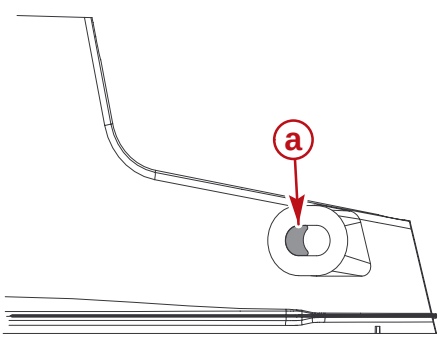
a - Spacer Positioned Forward (Bravo One and Two)
b - Spacer Positioned Aft (Bravo Three)

New Replacement Bravo Drive Shaft Housing

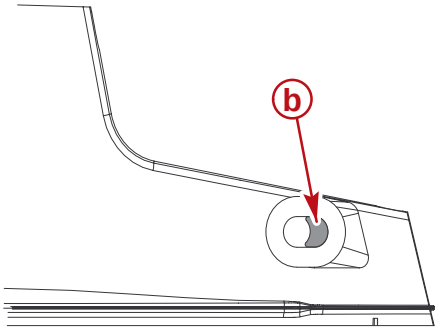
New replacement Bravo One, Two or Three drive shaft housings have a modified aft anchor pin hole. The original housing had a round anchor pin hole, which has now been changed to an elongated or slotted hole. This upgrade requires the use of an insert (P/N 808006) to position the anchor pin correctly.

On Bravo One and Two models the insert should be placed in the forward most position in the slotted hole.

For Bravo Three units the insert should be placed in the aft most position in the slotted hole. When using a newer drive shaft housing to replace an older Bravo Three housing the “trim-in” limit blocks are no longer needed. They should be removed. A “Tilt Limit” Spacer Kit (P/N 15768A3) should also be installed, to prevent the drive shaft housing and top cover from making any contact with the gimbal ring “U”-bolt.

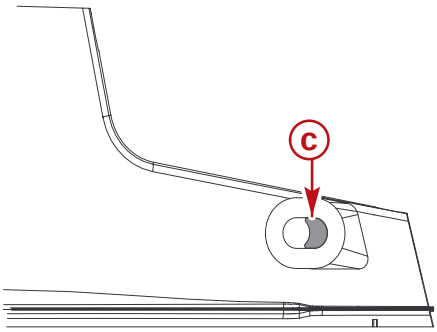


75157



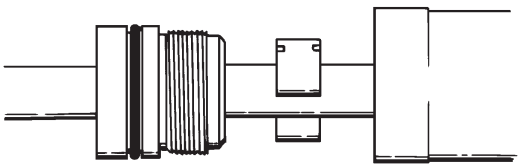
75158

a - Bravo One / Two Standard Insert Location
b - Bravo One / Two Optional Insert Location



75158

c - Bravo Three Trim-In Limit Spacer Location



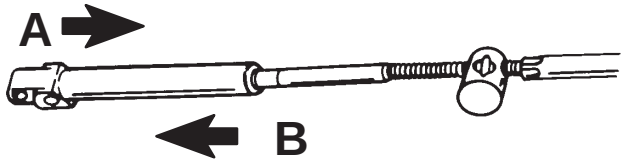
“Tilt Limit” Spacer Kit

Bravo Drive Unit Remote Control and Drive Unit Shift Cables Adjustment

NOTE: *Using Adjustment Tool (91-12427), shift cables can be adjusted without or with the sterndrive installed, using the following procedure.*

IMPORTANT: Drive unit propeller rotation is determined by the shift cable installation in the remote control.

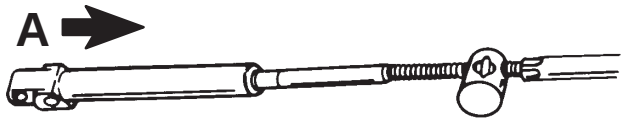
- **<u>Bravo One/Two</u> - If shift cable end guide moves in direction "A" when control lever is placed in Forward, remote control is set up for RIGHT HAND (RH) propeller rotation.**
- **<u>Bravo One/Two</u> - If shift cable end guide moves in direction "B" when control lever is placed in Forward, remote control is set up for LEFT HAND (LH) propeller rotation.**



71656

Bravo One And Two

- **<u>Blackhawk and Bravo Three</u> - Front propeller on drive unit is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction "A," when control lever is placed in Forward gear position.**

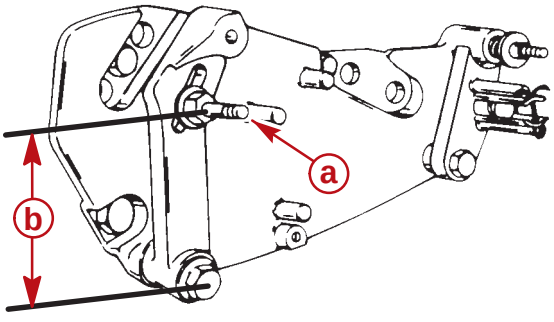


71656

Bravo Three And Blackhawk

IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables.

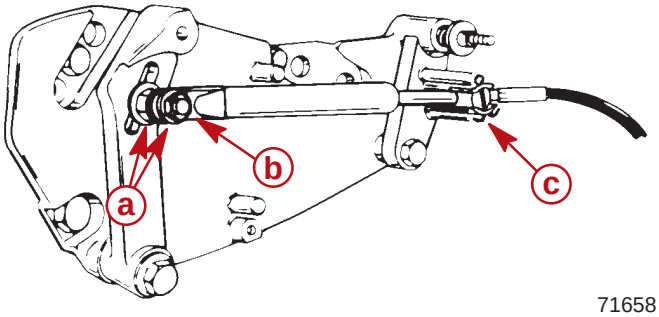
1. Install shift cable into remote control. (Refer to appropriate remote control instructions.)
2. Loosen stud and move it to dimension, as shown. Retighten stud.



71657

a - Stud
b - 3 inches (76mm) (Center of Pivot Bolt to Center of Stud)

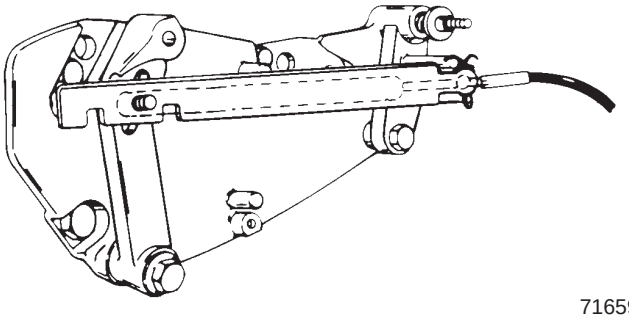
3. Install drive unit shift cable.



71658

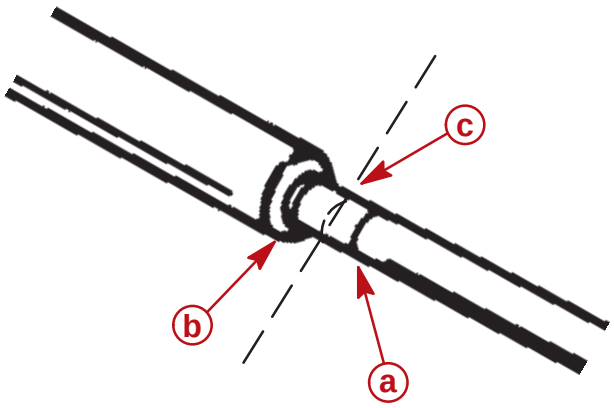
a - Washers (2)
b - Lock Nut - Tighten Until Contact. Then Back Off 1/2 Turn.
c - Cotter Pin - Insert from Top and Spread Both Ends

4. Place adjustment tool over drive unit shift cable, as shown. Hold tool in place, using a piece of tape over the barrel retainer.



71659

5. Locate center of remote control and control cable play (backlash).
   a. Shift remote control to neutral.
   b. Push in on control cable end with enough pressure to remove play and mark position “a” on tube.
   c. Pull out on control cable end with enough pressure to remove play and mark position “b” on tube.
   d. Measure distance between marks “a” and “b” and mark position “c” half-way between marks “a” and “b.”



71656

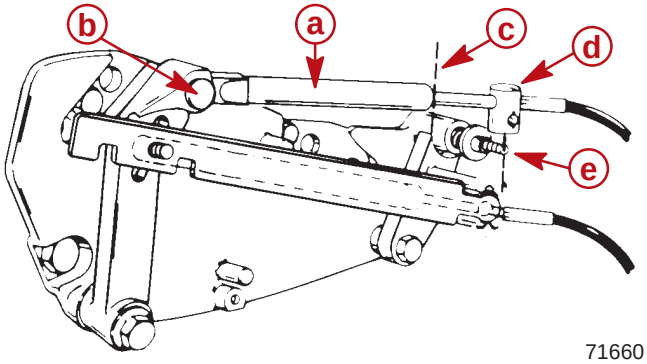
IMPORTANT: Be sure to keep center mark “c” aligned with control cable end guide edge when making the following adjustment.

6. Adjust control cable as follows:
   a. Temporarily install control cable end guide into shift lever and insert anchor pin.
   b. Adjust control cable barrel so that hole in barrel centers with vertical centerline of stud. Ensure that backlash center mark is aligned with edge of control cable end guide.

⚠CAUTION

DO NOT attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur.

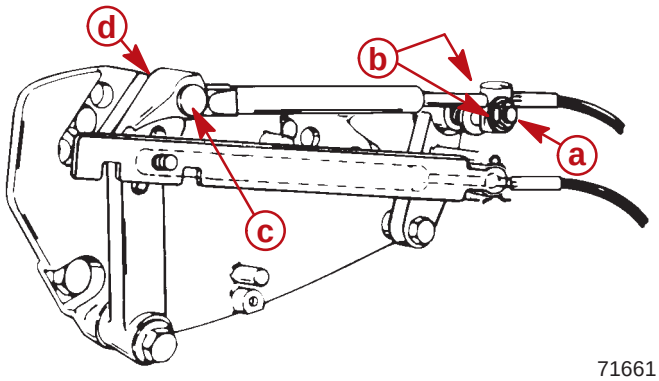
   c. Remove control cable end guide from shift lever by removing anchor pin.



71660

a - Control Cable End Guide
b - Anchor Pin
c - Backlash Center
d - Control Cable Barrel
e - Stud

7. Install control cable.



71661

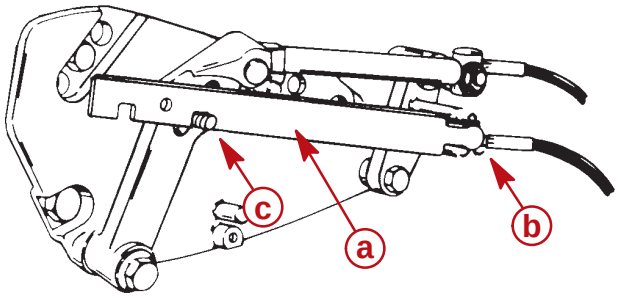
a - Lock Nut - Tighten Until Bottomed Out
b - Washers - Both Sides of Barrel
c - Anchor Pin
d - Cotter Pin (Not Visible) - Spread Both Ends

8. Remove adjustment tool.
9. Shift remote control lever into full forward position. Place end of adjustment tool in barrel retainer.

   RH ROTATION BRAVO ONE, TWO, THREE AND BLACKHAWK MODEL: Rear slot in tool should fit over shift lever stud.

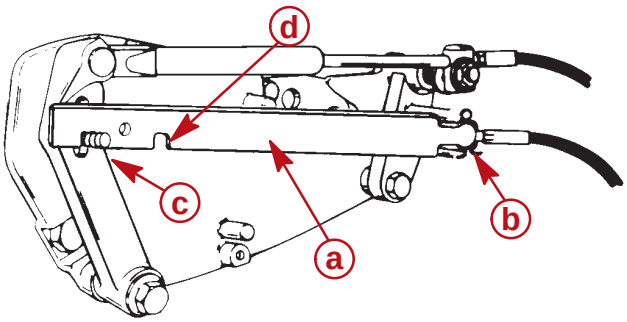
   LH ROTATION BRAVO ONE AND TWO: Forward slot in tool should fit over shift lever stud.

If slot does not fit over stud, loosen shift lever stud and slide stud up or down until slot in tool fits over stud. When adjustment is correct, retighten stud.



71662

RH Rotation Bravo One, Two, Three And Blackhawk



71663

LH Rotation Bravo One And Two

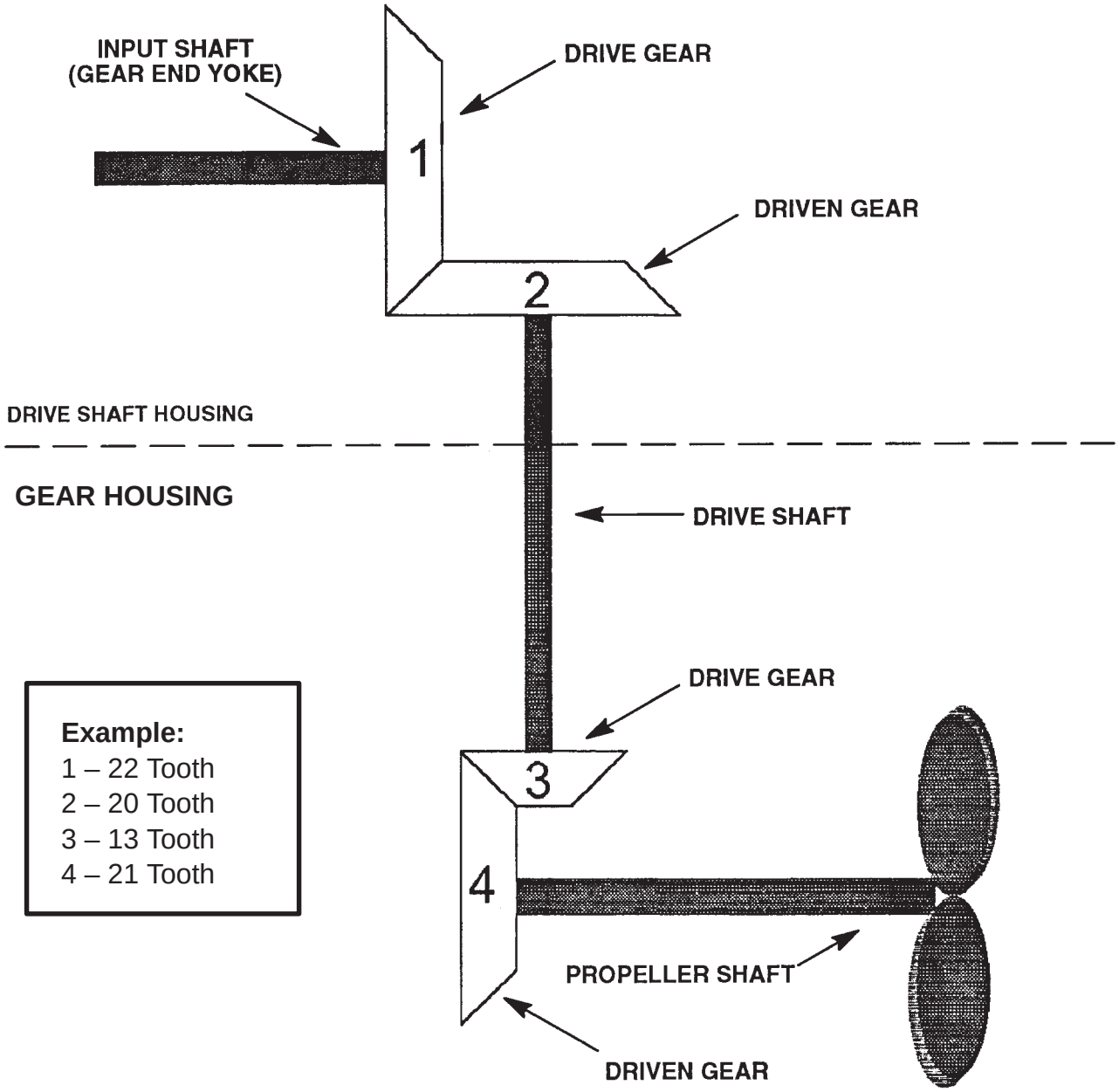
a - Adjustment Tool
b - Barrel Retainer
c - Shift Lever Stud
d - Shift Lever Adjustment Slot

10. Remove adjustment tool.
11. Lubricate shift cable pivot points with 30W oil.

Troubleshooting Shift Problems

NOTE: *See Troubleshooting information following Alpha Drive Unit Remote Control and Drive Unit Shift Cables Adjustment and Shift Cutout Switch Checking.*

Calculating Overall Drive Ratios



Overall Ratio = Ro
Ro = {Driven(2)/Drive(1)} x {Driven(4)/Drive(3)}
Ro = {20/22} x {21/13}
Ro = .909 x 1.615
Ro = 1.468 = 1.47
Ro = 1.47 Turns of Input Shaft to 1 turn of Prop Shaft

NOTES:

MERCRUISER
PDI AND MAINTENANCE
– LEVEL I

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D

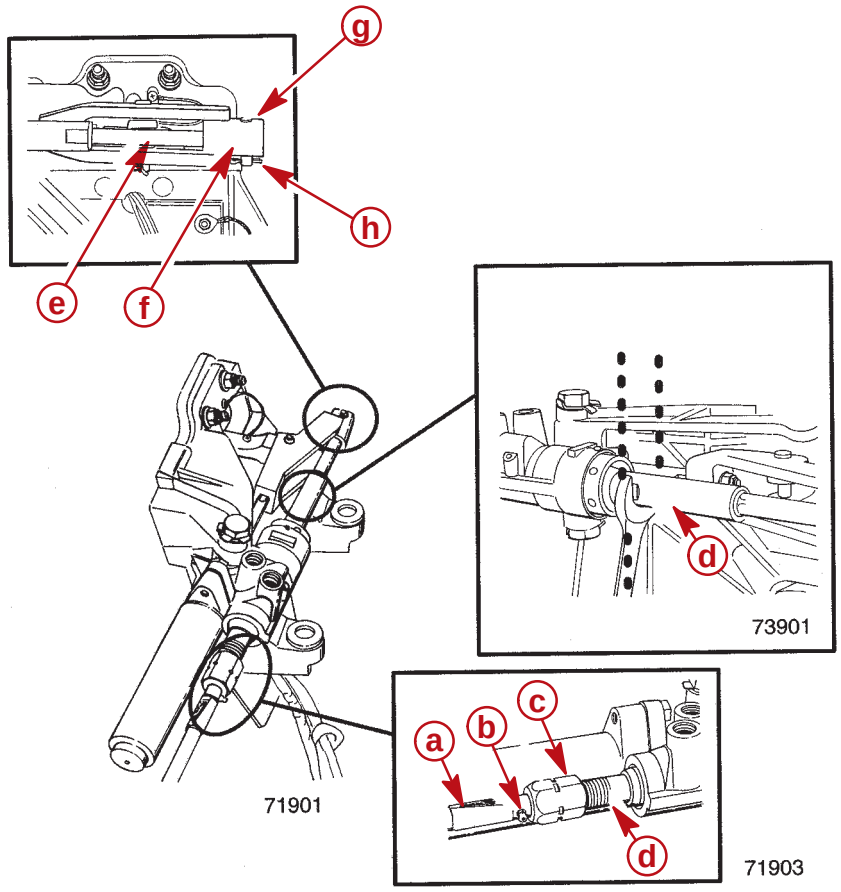
POWER STEERING INSTALLATION

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The flat surfaces on the cable guide tube of a DHB power steering valve assembly must be vertical as shown below.

1. Install steering cable and secure with hardware as shown.
2. Using a suitable wrench hold the flat surfaces on the cable guide tube in the vertical position. Torque coupler nut to 35 lb. ft. (47 N·m). **Be certain the flat surfaces are still aligned vertically after torque is applied to coupler nut. This is done to assure proper internal alignment of the oil passages.**



a - Steering Cable
b - Grease Fitting
c - Cable Coupler Nut
d - Cable Guide Tube
e - Steering Cable End
f - Clevis
g - Clevis Pin
h - Cotter Pin

⚠ CAUTION

Steering cable outer casing must be free to move back-and-forth tor steering system to function properly. Do not fasten any items to steering cable.

NOTES:

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PDI AND MAINTENANCE
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THROTTLE CABLE ADJUSTMENT

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Bravo Throttle Cable Installation and Adjustment	1E-4

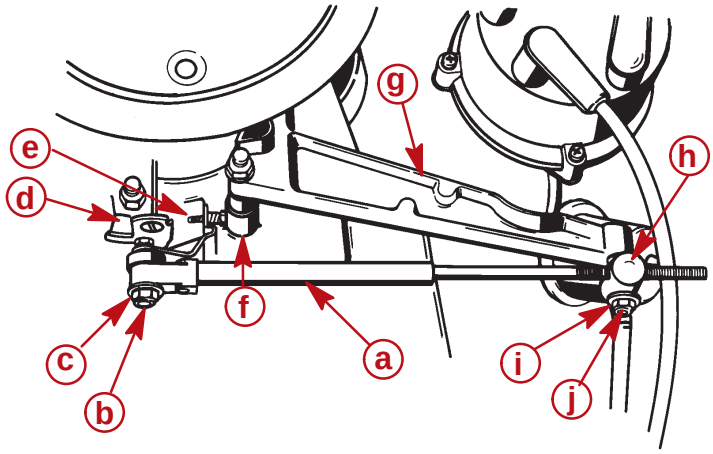
Alpha Throttle Cable Installation and Adjustment

Carbureted Models

1. Place remote control handle(s) in NEUTRAL/IDLE position.

IMPORTANT: Be sure that cable is routed to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

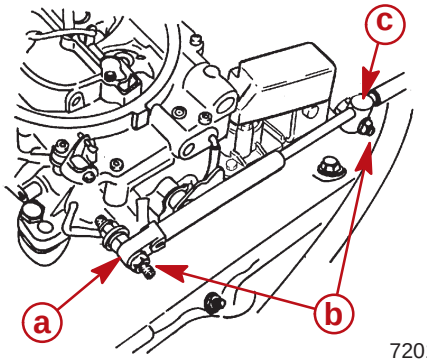
2. Install cable end guide on throttle lever and then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on the cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
3. Secure throttle cable with hardware as shown. DO NOT OVERTIGHTEN as cable must pivot freely. Tighten securely and then loosen locknuts 1/2 turn to allow cable to move freely.
4. Place remote control throttle lever in the WOT position. Ensure that throttle shutters are completely open.
5. Return remote control throttle lever to idle position and ensure that throttle lever contacts idle speed adjustment screw.



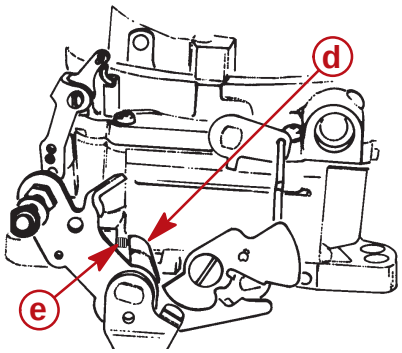
76900

2 BBL V6 and V8 Models

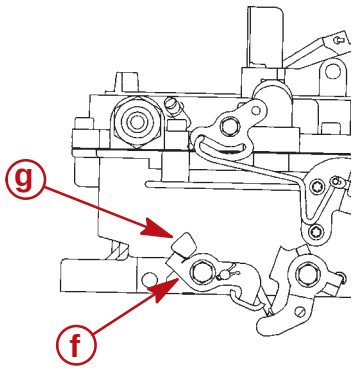
- **a** - Cable End Guide
- **b** - Throttle Lever Screw
- **c** - Locknut and Flat Washer (Small)
- **d** - Throttle Lever
- **e** - Idle Speed Adjustment Screw
- **f** - Idle Cam
- **g** - Throttle Bracket
- **h** - Cable Barrel
- **i** - Flat Washer and Locknut (Large)
- **j** - Throttle Cable Anchor Stud



72014



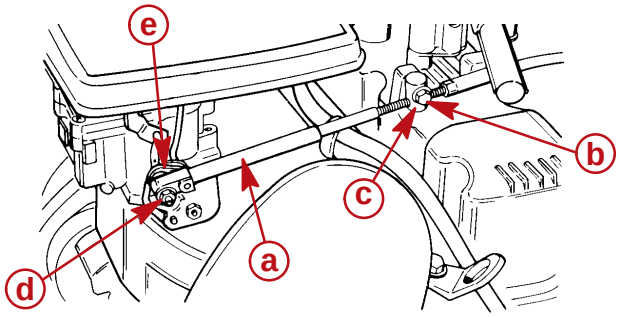
70392



71159

4 BBL V6 Models

- **a** - Cable End Guide
- **b** - Flatwasher and Locknut
- **c** - Cable Barrel
- **d** - Throttle Lever [Contacts "**e**" in Idle Position]
- **e** - Idle Speed Adjustment Screw
- **f** - Throttle Shaft Lever [Contacts "**g**" at WOT Position]
- **g** - Carburetor Body Casting



50634

3.0L Models

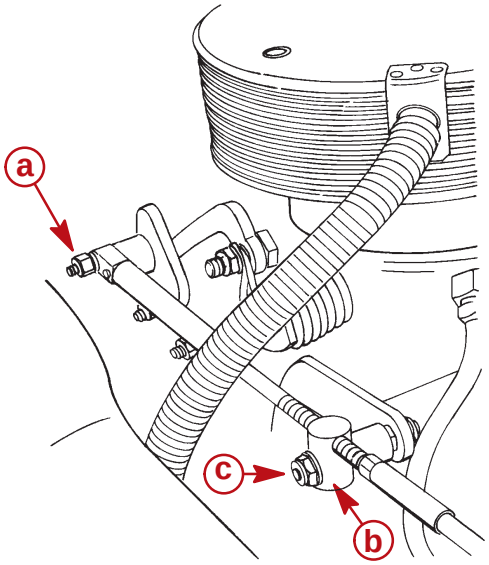
- **a** - Cable End Guide
- **b** - Anchor Screw - Tighten Securely
- **c** - Cable Barrel
- **d** - Elastic Stop Nut and Flat Washer
- **e** - Throttle Lever

EFI Models

1. Place remote control handle(s) in neutral idle position.

IMPORTANT: Be sure that cable is routed to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



76899

Typical

- **a** - Flat Washer and Locknut
- **b** - Cable Barrel
- **c** - Flat Washer And Locknut

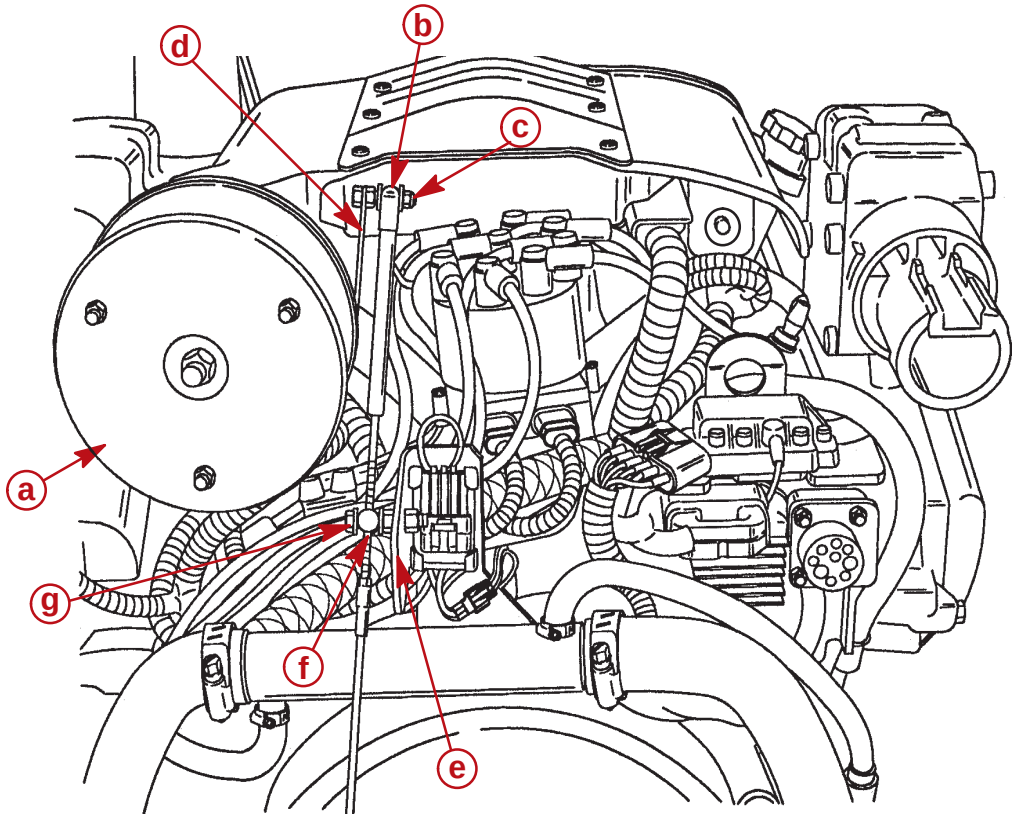
3. Secure throttle cable with hardware as shown and tighten securely. Loosen locknut "**a**" 1/2 turn.
4. Place remote control throttle level in the wide open throttle (WOT) position. Ensure that throttle plates are completely open.
5. Return remote control throttle lever to idle position and ensure that throttle lever is completely closed.

Bravo Throttle Cable Installation & Adjustment

1. Place remote control handle(s) in neutral idle position.

IMPORTANT: Be sure that cable is routed in such a way to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Remove the flame arrestor (a).
3. Install cable end guide (b) on throttle lever stud, then push cable barrel (f) lightly toward throttle lever end. (This will place a slight pre-load on shift cable to avoid slack in cable when moving remote control lever.)
4. Adjust barrel (f) on throttle cable to align with anchor bracket stud (g).
5. Secure throttle cable with hardware as shown. Tighten until nut bottoms, Then back off 1 full turn. Cable must pivot freely.
6. Place remote control throttle lever in the wide-open-throttle (WOT) position. Ensure that throttle shutter is completely open.
7. Return remote control throttle lever to idle position. Ensure that throttle lever contacts the stop. Adjust cable barrel to achieve these settings.
8. Install flame arrestor and tighten securely.



a - Flame Arrestor
b - Cable End Guide
c - Throttle Lever Stud, Elastic Stop Nut and Flat Washer - **(Tighten Until Nut Bottoms Out, Then Back Off 1 Full Turn)**
d - Throttle Lever
e - Anchor Bracket
f - Cable Barrel
g - Anchor Bracket Stud, Flat Washer and Elastic Stop Nut

MERCRUISER PDI AND MAINTENANCE – LEVEL I

1F

PREDELIVERY PREPARATION

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Predelivery Preparation

NOTICE to INSTALLER
Before starting Predelivery, read “General Information” and “Installation Requirements” completely.

Battery Connection

IMPORTANT: Engine electrical system is negative (–) ground.

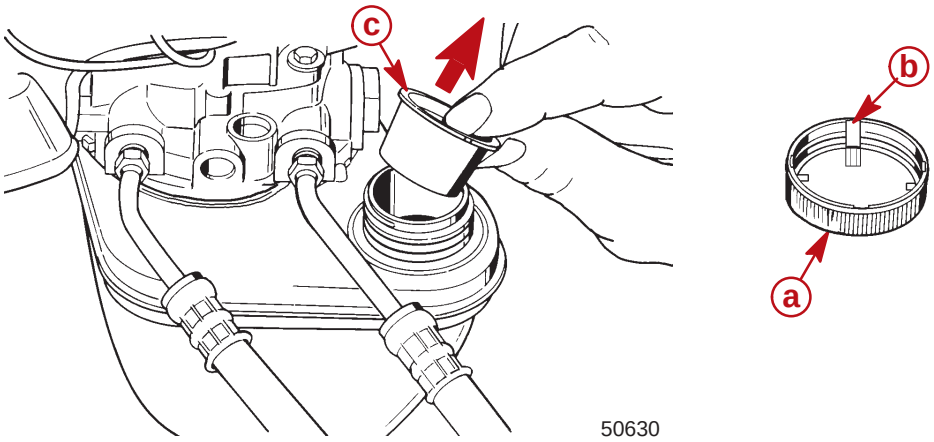
1. Connect engine positive (+) battery cable (usually red) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually black) to negative (–) battery terminal.
3. Connect Power Trim pump black (–) battery cable to negative (–) battery terminal and pump red (+) battery cable to positive (+) battery terminal.
4. Make sure that all battery terminal connections are tight; then, spray terminals with a battery connection sealant to help retard corrosion.

Power Trim Pump

- **Check oil level with sterndrive unit in the full down position.**
- **Use only Quicksilver Power Trim and Steering Fluid, SAE 10W-30, or 10W-40 engine oil in power trim system.**

IMPORTANT: Older style reservoirs which may not have the vented cap may have a vent hole in the upper side of the reservoir filler neck. Never install an un-vented cap onto an un-vented reservoir or damage to the pump could occur.

1. Unscrew fill cap (a) and remove “Caplug” (c) from fill neck, then replace fill cap. Fill cap is vented and should periodically be checked to ensure vents are clear.

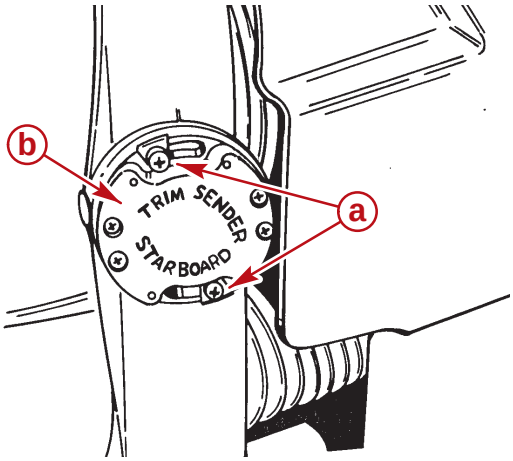


a - Fill Cap
b - Vent Slots
c - Cap plug (Remove and Discard Before Operating Pump)
d - Fill Neck

2. Raise and lower drive unit (to the full up position) 6 to 10 times to purge air from system. Check oil level visually, (with drive unit in the full down position). Oil level should be maintained at bottom lip of fill neck.

Trim Position Sender Adjustment (if applicable)

1. Loosen both trim position sender retaining screws.



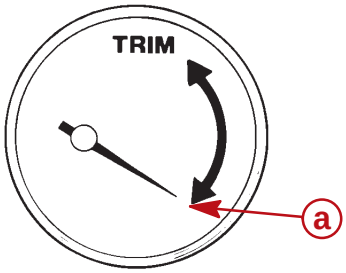
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a - Retaining Screws
b - Trim Position Sender

⚠ CAUTION

DO NOT start engine in the following step or damage to drive unit and engine could result from lack of cooling water.

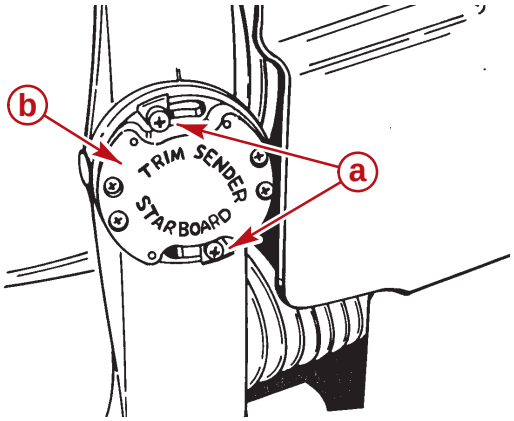
2. Turn ignition key to the RUN position.
3. Trim drive unit to the full DOWN/IN position.
4. Rotate trim position sender as required to show full DOWN/IN position on dashboard instrument as shown.



71671

a - Trim Gauge Needle

5. Tighten retaining screws and turn ignition key to the OFF position.



71220

a - Retaining Screws
b - Trim Position Sender

Small Block and V6 Transom with ECM 555 equipped engines:

Connect trim position sender wires (from transom assembly) to engine harness. One lead will go to wire marked “ground”. The other will connect to the orange/gray wire for analog gauges or the orange/white wire for digital gauges.

Connect the trim limit switch wires to power trim harness at the pump. Trim lead with blue sleeve connects to blue/white wire in harness. Trim lead with purple sleeve connects to purple/white wire in harness.

496 Mechanical with Smart transom:

Connect the three-wire sensor (from transom assembly) to the plug on the aft port side of the engine.

Connect the trim sender wires (from transom assembly) to the individual wires on aft starboard side of engine.

Power Steering

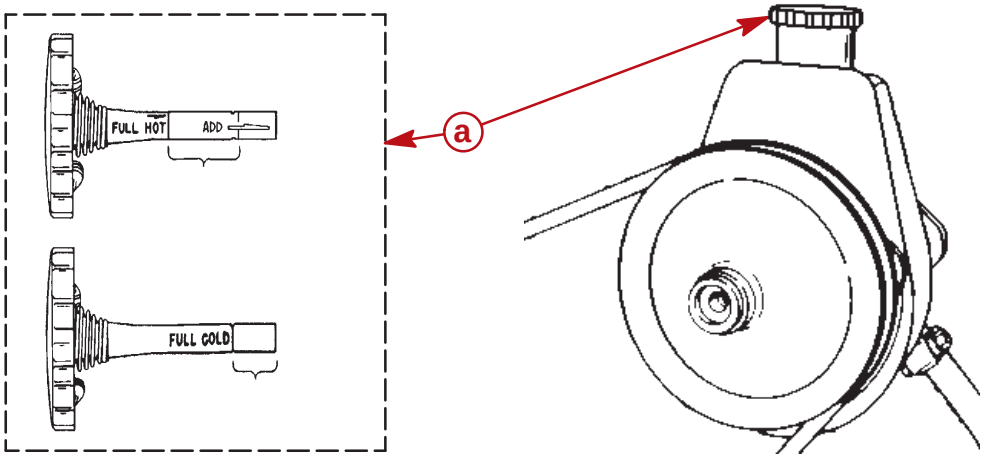
IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or Dexron III automatic transmission fluid (ATF), in power steering system.

⚠ CAUTION

DO NOT RUN POWER STEERING DRY, or pump will be damaged.

1. Position drive unit so that it is straight back.
2. Remove fill cap from power steering pump reservoir, and check fluid level.
3. Add fluid as required.

4. When first starting engine, be prepared to add fluid to pump.

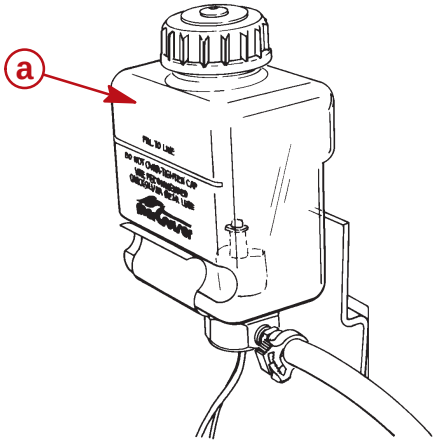


a - Fill Cap/Dipstick

5. Cycle the steering full turns, both port and starboard several times to help purge air from the system.

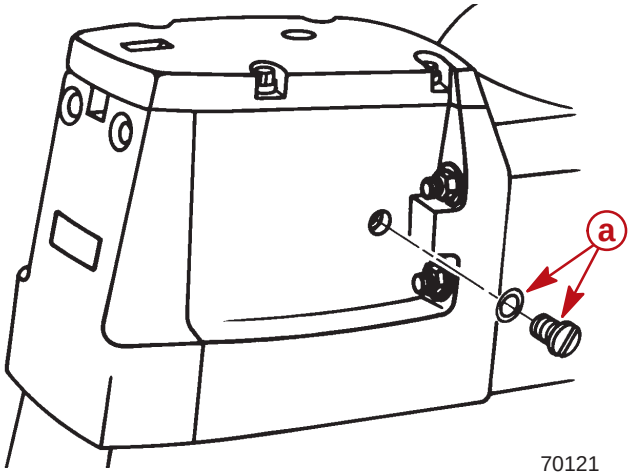
Drive Unit Gear Lube Monitor

- **Always check oil level when drive is cool and engine is shut down.**
- **Oil level in reservoir bottle will rise and fall during drive operation.**



a - Drive Unit Gear Lube Monitor Mounted on Transom

1. With drive in full down position, remove drive unit vent plug and sealing washer.



a - Vent Plug and Sealing Washer

IMPORTANT: Failure to fill drive unit to level of vent hole will result in a low drive oil level. Oil Reservoir only MAINTAINS drive oil level and will not correct an improperly filled drive unit.

2. Fill Oil Reservoir bottle with Quicksilver High Performance Gear Lube. When oil starts to run out the drive unit vent hole (after oil fills the entire length of hose between reservoir and drive unit), re-insert vent screw and sealing washer, and tighten securely.
3. Fill Oil Reservoir bottle to “FILL” mark. Lubricate O-ring in reservoir cap with sterndrive oil (to insure ease of installing and removing cap) and install cap. Do not overtighten cap.
4. Recheck oil level after first use.

Propeller Installation

IMPORTANT: Correct rotation propeller MUST match direction of rotation of propeller shaft.

⚠ WARNING

Be sure that remote control is in neutral position and ignition key is removed from switch prior to installing propeller.

⚠ WARNING

Place a block of wood between the anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from turning when tightening propeller nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft spline with one of the following Quicksilver lubricants; then install propeller as shown.

FRESH WATER

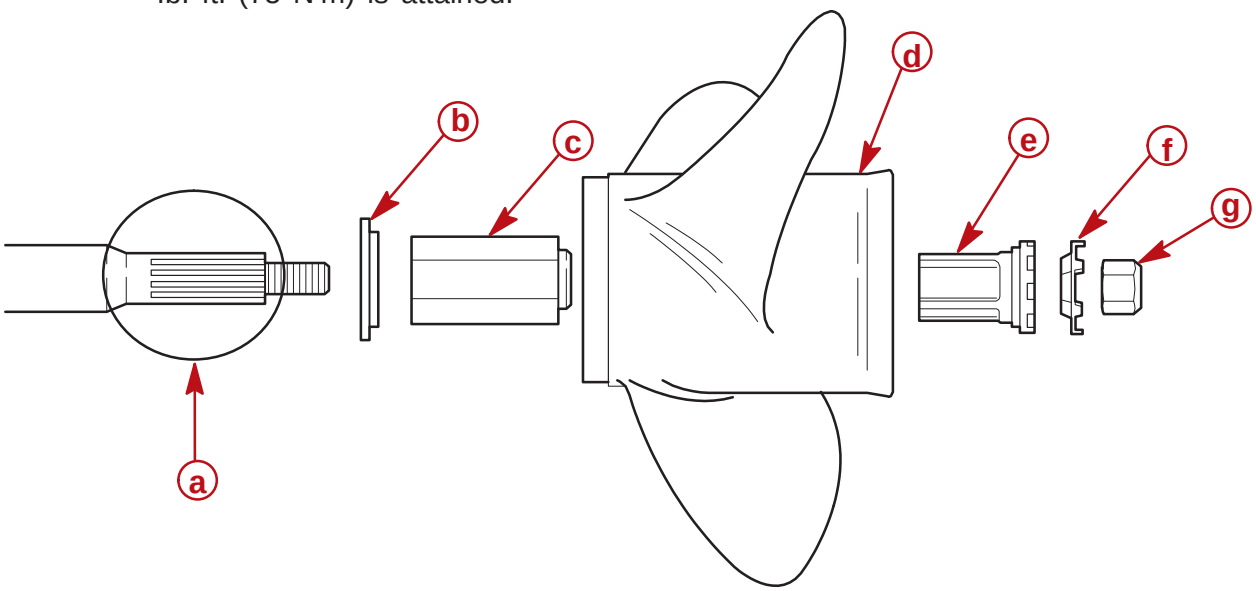
- Anti-Corrosion Grease (92-802867A1).
- Special Lubricant 101 (92-802865A1).
- 2-4-C Marine Lubricant (92-802859A1).

SALT WATER

- Anti-Corrosion Grease (92-802867A1).

IMPORTANT: Installation is correct when at least 2 threads of propeller shaft are exposed thru propeller nut after torquing it.

1. Install propeller with attaching hardware as shown. Tighten nut until a minimum of 55 lb. ft. (75 N·m) is attained.



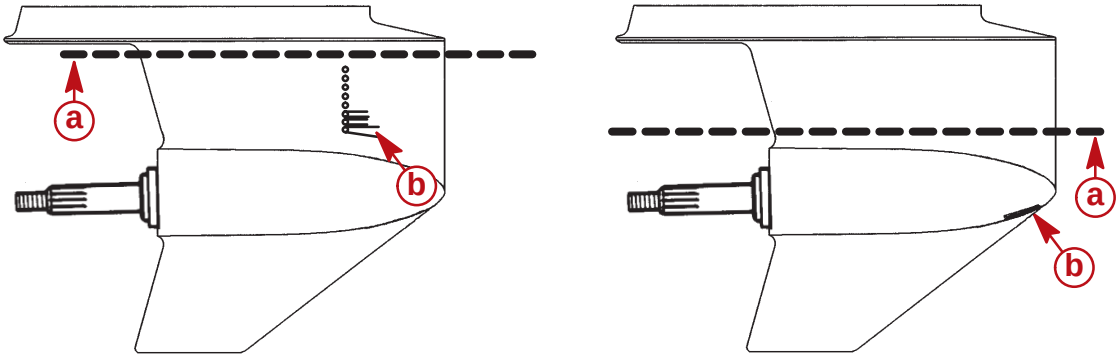
a - Apply Lubricant to Exposed Area of Propshaft
b - Forward Thrust Washer
c - Drive Sleeve
d - Propeller
e - Drive Sleeve (Aft) Adaptor
f - Locking Tab Washer
g - Propeller Nut

Test Running Engine

⚠ WARNING

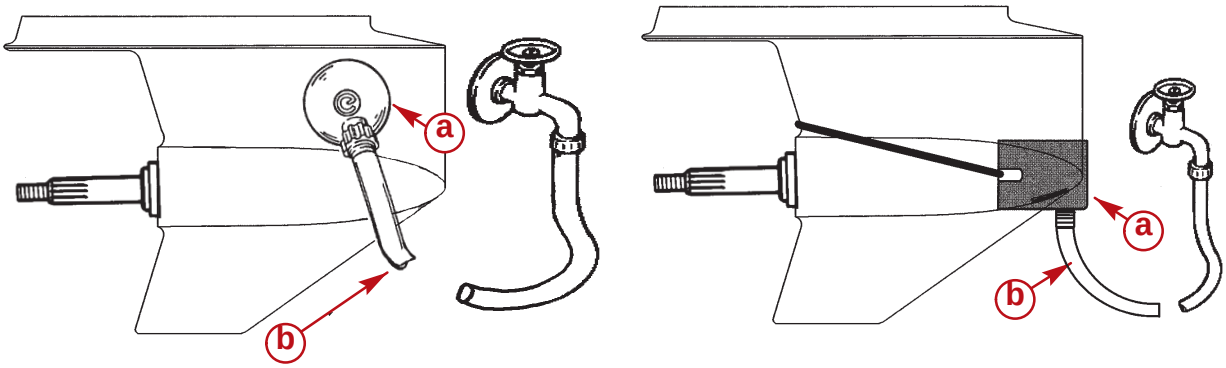
If engine is to be tested with boat out of water, the propeller must be removed to avoid injury.

IMPORTANT: If using a test tank, ensure water level is above water intake holes.



a - Minimum Water Level
b - Water Intake Holes

IMPORTANT: If using flush test device, install over water intake holes and connect a water hose as shown. Do not use full water tap pressure. Also, do not run engine above 1500 rpm, as suction created could cause water hose to collapse causing water supply to be cut off.



a - Flush - Test Device
b - Garden Hose Hook-up - (Do Not Use Full Water Tap Pressure)

⚠ WARNING

Do not leave helm unattended when making test with boat-in-the-water.

1. Ensure that cooling system drain plugs, petcocks and hoses are installed and tight.

NOTE: *Refer to "Operation and Maintenance Manual" for operating specifications and fluid capacities.*

2. Check crankcase oil level.
3. Check sterndrive unit oil level.
4. Check serpentine belt tension.
5. **Test Audio Warning System as follows:**
   a. Turn key switch to the RUN position. Buzzer should sound immediately.
   b. Start engine as described in the following step. The buzzer should stop as soon as the engine is running.
6. Start engine and run at idle RPM until Water temperature is normal.
7. Watch all gauges for normal readings.
8. Turn steering wheel starboard, then port, and check to ensure drive unit turns the correct direction.
9. Inspect engine compartment for water, oil, fuel and exhaust leaks.

⚠ CAUTION

If Power Steering pump lugs when steering wheel is turned to end of travel in either direction (hard right or left), damage to the transom assembly and/or Power Steering system could occur. If pump lugs when performing the following checks, release steering wheel immediately.

10. Check for lugging condition.
    a. Turn steering wheel completely **left** and continue to exert pressure. If pump lugs (engine RPM drops and/or power steering pump tone changes), proceed as follows:
       (1.) Check for an obstruction between gimbal ring and gimbal housing, and between all moving steering components.
       (2.) Check that steering lever is not contacting cutout in transom. If contact is being made, modify cutout.
       (3.) Check fluid level.
    b. Turn steering wheel **right** until it stops and continue to apply pressure. If pump lugs (engine rpm drops and/or power steering pump tone changes), check the following.
       (1.) Check same items as (1) and (2) above.
       (2.) Check steering cable end dimension with cable FULLY EXTENDED. (See "Installation Requirements" for proper steering cable dimensions.)
       (3.) Check fluid level.

Boat-In-The-Water Tests

ENGINE IDLE SPEED ADJUSTMENT

⚠ CAUTION

Avoid engine damage. Ensure that cooling water is supplied to the engine if it will be run with boat out of the water. See instructions in the Operation and Maintenance Manual entitled "Flushing Cooling System" for instructions on connecting flush device.

Engine should idle at rpm (as specified in "Operation and Maintenance Manual") with engine at normal operating temperature. If idle speed is incorrect, proceed as follows:

1. Ensure that throttle cable has been adjusted properly.
2. If idle speed is still not correct, it may be necessary to perform EFI System Diagnostic Tests on the idle circuit. Refer to the appropriate Mercury MerCruiser Service Manual for procedures.

WIDE-OPEN THROTTLE TEST

IMPORTANT: To run engine at full throttle before the break-in period is complete, follow this procedure.

- **Start engine and run at idle RPM until normal operating temperature is reached.**
- **Run boat up on plane.**
- **Advance engine RPM (in 200 RPM Increments) until engine reaches its maximum rated RPM.**

To test if the correct propeller has been installed, operate boat (with normal load on board) at WOT and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under a heavy load, engine speed will not fall below specifications. If engine speed is too high, replace propeller with a higher pitch propeller. Normally, a 300 to 400 RPM change exists between propeller pitches.

COLD WEATHER OR EXTENDED STORAGE

⚠ CAUTION

If Power Package will not be used for an extended period of time or will be exposed to freezing temperatures, drain water from seawater circuit of cooling system, as explained in owner's "Operation, Maintenance, and Warranty Manual." Water MUST BE drained to prevent corrosion and freeze damage to engine.

⚠ CAUTION

Sterndrive unit should be stored in full "down" position. Universal Joint bellows may develop a "set" If unit is stored in raised position and may fail when unit Is returned to service.

Predelivery Inspection

Not Applicable	Check/ Adjust	CHECK BEFORE RUNNING
☐	☐	Drain plug in and petcocks closed
☐	☐	Seawater inlet valve open
☐	☐	Engine mounts tight
☐	☐	Engine alignment
☐	☐	Drive unit fasteners torqued
☐	☐	Power trim cylinders fasteners tight
☐	☐	Battery fully charged and secured
☐	☐	All electrical connections tight
☐	☐	Exhaust system hose clamps tight
☐	☐	All fuel connections tight
☐	☐	Correct rotation propeller (installed and torqued)
☐	☐	Throttle, shift and steering system fasteners tightened properly
☐	☐	Throttle plates open and close completely
☐	☐	Crankcase oil level
☐	☐	Power trim oil level
☐	☐	Sterndrive unit oil level
☐	☐	Power steering fluid level
☐	☐	Closed cooling level
☐	☐	Transmission fluid level
☐	☐	Alternator belt tension
☐	☐	Seawater pickup pump belt tension
☐	☐	Power steering pump belt tension
☐	☐	Audio warning system operation

Not Applicable	Check/ Adjust	ON THE WATER TEST
☐	☐	Engine alignment (Inboards only)
☐	☐	Starter neutral safety switch operation
☐	☐	Water pump operation
☐	☐	Instruments(s) operation
☐	☐	Fuel leaks
☐	☐	Oil leaks
☐	☐	Water leaks
☐	☐	Exhaust leaks
☐	☐	Ignition timing
☐	☐	Idle_____rpm, within specifications
☐	☐	Forward - Neutral - Reverse gear operation
☐	☐	Steering operation throughout range
☐	☐	Acceleration from idle rpm
☐	☐	WOT_____rpm within specifications (in FORWARD gear)
☐	☐	Power trim operation
☐	☐	Trim tab adjustment
☐	☐	Boat handling
		AFTER ON WATER TEST
☐	☐	Propeller nut torque
☐	☐	Fuel, oil, coolant, water and fluid leaks
☐	☐	Oil and fluid levels
☐	☐	Apply Quicksilver Corrosion Guard to engine package
☐	☐	C.A.R.B. Hang Tag and Owners Manual in boat[1]
☐	☐	C.A.R.B. Decal properly affixed to boat hull[1]

[2] *If registered to a CA resident.*

MERCRUISER PDI AND MAINTENANCE – LEVEL I

1G

WINTERIZATION AND RECOMMISSIONING

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The following example uses a 3.0L Alpha engine as a typical MerCruiser power package. For any particular engine, the appropriate service manual should be used.

Cold Weather or Extended Storage

Precautions

⚠ CAUTION

Sterndrive unit should be stored in full DOWN position. Universal Joint bellows may develop a "set" if unit is stored in raised position and may fail when unit is returned to service.

⚠ CAUTION

If Power Package will not be used for an extended period of time or will be exposed to freezing temperatures, drain water from seawater section of cooling system. Water MUST BE drained to prevent corrosion and freeze damage to engine.

⚠ CAUTION

If boat is to remain in water after draining, seawater inlet hose must be removed and plugged. The plug will prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system:

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

⚠ CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠ CAUTION

A discharged battery can be damaged by freezing.

IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (a nontoxic and environmentally safe) antifreeze be used in seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Power Package Layup

CARBURETED MODELS

NOTE: *Refer to MC Service Bulletin 2001-15 for additional information on EFI/MPI procedures.*

NOTICE

Refer to "Cold Weather or Extended Storage Precautions" in this section, BEFORE proceeding.

1. Follow instructions "a" or "b" depending on type fuel available during layup:
   a. **If boat is to be placed in storage with fuel in fuel tanks that does not contain alcohol:** Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat the gasoline. Follow instructions on container.
   b. **If boat is to be placed in storage with fuel in fuel tanks that does contain alcohol (if fuel without alcohol is unavailable):** Fuel tanks should be drained as completely as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Follow instructions on container.

IMPORTANT: If boat is to be placed in storage with fuel containing alcohol in fuel tanks refer to "Fuel" in this section for additional information.

2. Replace the water separating fuel filter as outlined in Fuel Delivery Systems, "Water Separating Fuel Filter," of appropriate service manual.
3. Supply water to the seawater pickup pump as outlined in "Flushing Cooling System."
4. Start the engine and check for fuel leaks. If leaks exist, stop the engine immediately. Recheck filter installation.
5. Start the engine. Operate at idle rpm until it reaches normal operating temperature and the fuel stabilizer has been circulated. Shut off the engine.
6. Change the engine oil and filter.
7. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system as outlined in "Flushing Cooling System."

8. Prepare fuel system for extended storage as follows:
    a. Close the fuel shut-off valve, if equipped. If no fuel shut off valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.
    b. Remove flame arrestor assembly and start engine.
    c. While operating engine at fast idle (1000-1500 rpm), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores.
    d. Squirt the remaining 2 ounces (57 g) of Storage Seal (or oil) rapidly into carburetor, just as the engine begins to stall, due to lack of fuel. Allow engine to stop.
    e. Turn ignition key to OFF position.
    f. Refer to “Flushing Cooling System” and appropriately remove water supply to the sea-water pickup pump.
9. Clean flame arrestor and crankcase ventilation hoses and reinstall.
10. Drain seawater section of cooling system as outlined in “Draining Instructions.”
11. **Closed Cooling System Models:** Test coolant to ensure that it will protect against freezing to the lowest temperature expected during storage.
12. Lubricate all items outlined in “Lubrication.”
13. Service batteries. Refer to manufacturer’s instructions.
14. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
15. For drive unit layup information, refer to appropriate Sterndrive Manual.

⚠ CAUTION

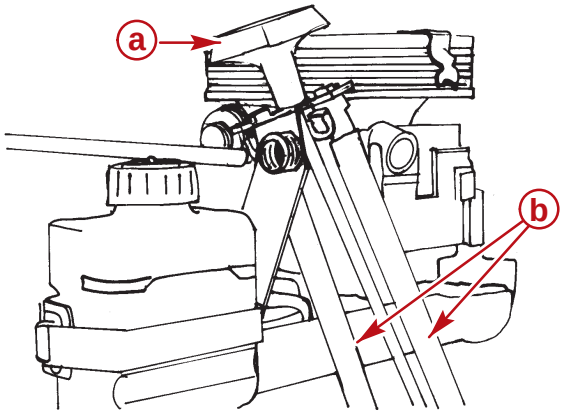
Sterndrive unit should be stored in full “down” position. Universal Joint bellows may develop a “set” if unit is stored in raised position and may fail when unit is returned to service.

Draining Instructions

(Typically consult service manual for a particular engine)

Single Point Drain System

Some models are equipped with a single point drain system consisting of 2 hoses with hardware and a T-handle retrieval tool (shown below). This system drains the seawater section of the engine only.

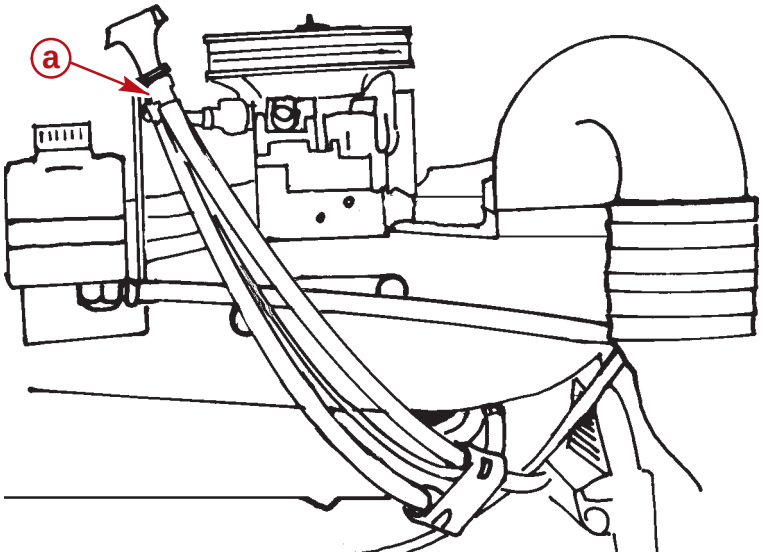


76242

a - T-handle Retrieval Tool
b - Hoses

If your engine is equipped with this device, follow this procedure:

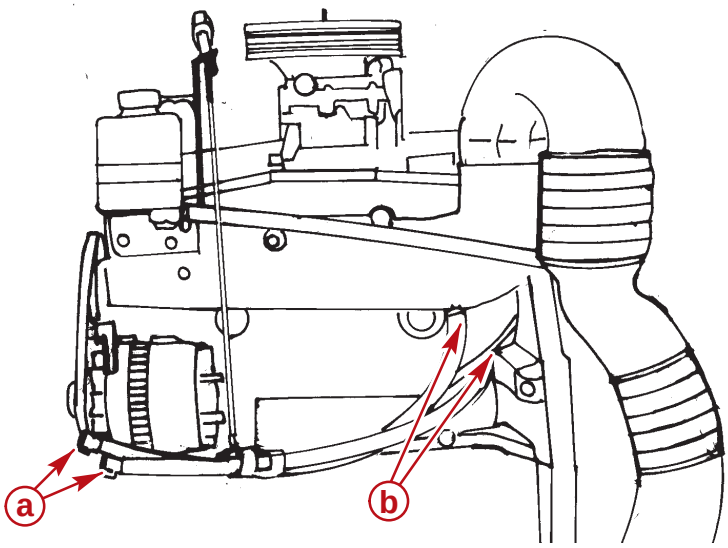
1. Detach the hoses from the top fittings.



76243

a - Fittings

2. Lower hoses into bilge. If hoses have developed a “set,” T-handle retrieval tool can be used to push hoses below their connection point.



76244

a - Hoses
b - Connection Points

IMPORTANT: Hoses must be lowered below their connection point on the engine in order to drain completely.

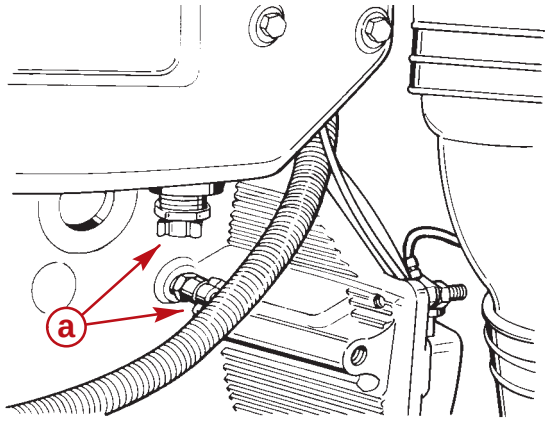
3. If hoses do not drain, use wire to remove blockage.
4. Pull hoses back into original position after draining is complete. Reconnect to fittings.

Draining Seawater (Raw-Water) Cooled Models

NOTICE

Refer to “Cold Weather or Extended Storage Precautions” in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from cylinder block and manifold.



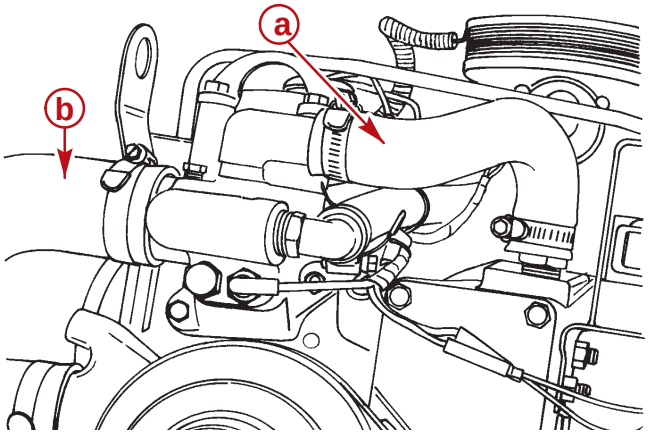
71424

a - Drain Plug (Port and Starboard)

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

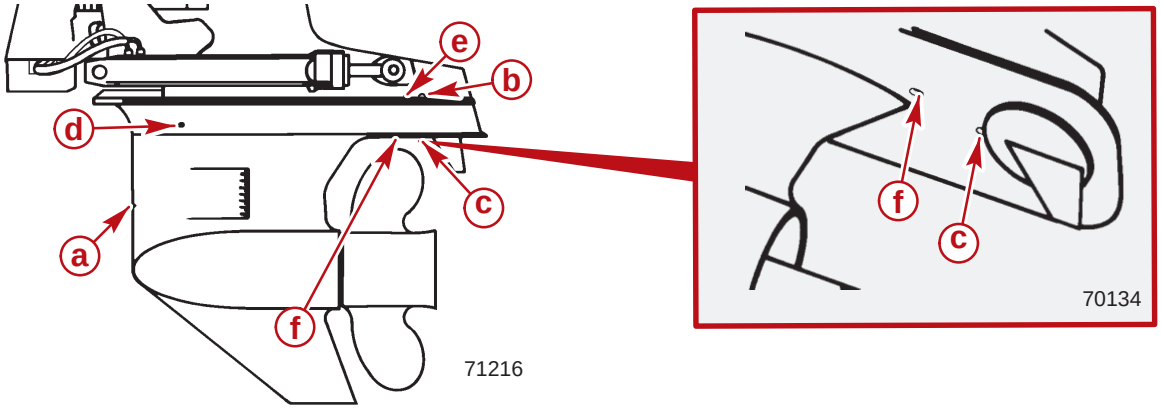
4. Remove and lower the hoses to allow them to drain.



75815

a - Inlet Hose
b - Circulating Pump Hose

5. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



a - Speedometer Pitot Tube
b - Gear Housing Cavity Drain Hole
c - Trim Tab Cavity Vent Hole
d - Trim Tab Cavity Drain Passage
e - Gear Housing Water Drain Hole (One Each - Port and Starboard)
f - Gear Housing Cavity Vent Hole

6. Crank engine over SLIGHTLY, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

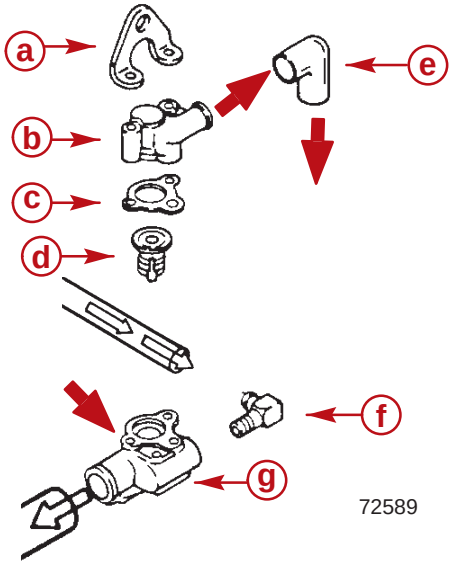
⚠ CAUTION

If boat is in the water or is to remain in the water, seacock (if equipped) must remain closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, seawater inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the seawater inlet hose reconnected prior to starting the engine.

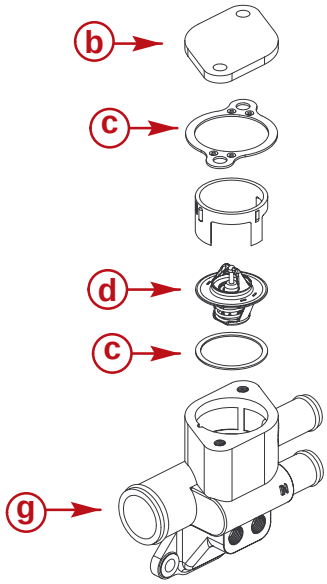
7. After cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

8. For additional assurance against freezing and rust, remove the thermostat cover and thermostat. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb-ft (41 Nm).



72589



76246

a - Lifting Eye
b - Cover
c - Gasket
d - Hose
e - Thermostat
f - Fitting
g - Housing

NOTE: *Hoses shown removed only to indicate flow. Do not remove hoses.*

Draining Seawater Section of Closed Cooled (Coolant) Models

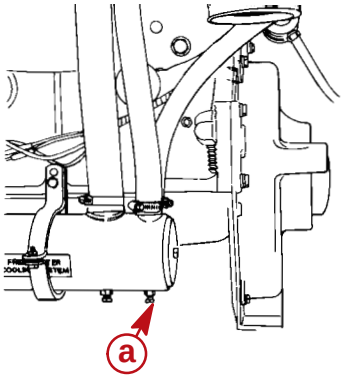
NOTICE

Refer to “Cold Weather or Extended Storage Precautions” in this section, BEFORE proceeding.

⚠ CAUTION

If boat is in the water or is to remain in the water, seacock (if equipped) must remain closed until engine is to be restarted to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent contaminated water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

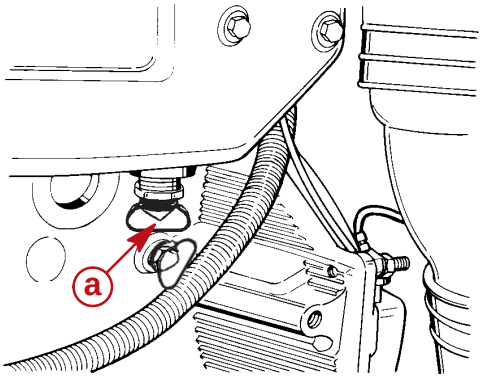
1. Ensure engine is as level as possible to ensure complete draining of cooling system.
2. Remove drain plug from the following locations:
   a. Aft (rear) drain plug from the heat exchanger.



73581

a - Heat Exchanger Drain Plug

   b. Bottom of exhaust manifold.



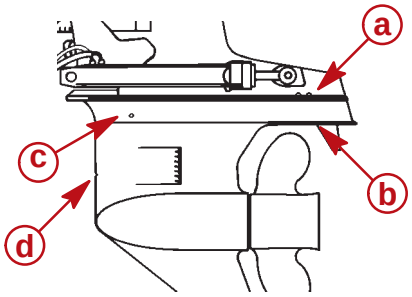
75177

a - Exhaust Manifold Drain Plug

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift or bend hoses to allow water to drain completely.*

4. Make sure gear housing water vent and drain holes, speedometer pitot hole and trim tab cavity vent and drain holes are open and unobstructed.



71216

a - Vent Holes
b - Anode Cavity Drain Holes
c - Drain Hole
d - Speedometer Pitot Hole

5. Crank engine over slightly with starter motor to purge any water trapped in seawater pick-up pump. Do not allow engine to start.
6. After cooling system has been drained completely, install drain plugs, reconnect hoses and tighten all hose clamps securely.

Draining Instructions for New Drain Systems

⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.

⚠ CAUTION

Do not operate engine with drain system open. Excess water in bilge can damage engine or cause boat to sink.

IMPORTANT: Boat must be as level as possible to ensure complete draining of cooling system.

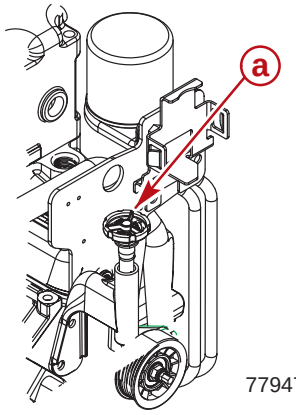
Your power package is equipped with one of three drain systems. Refer to Identification on the following page to determine which instructions apply to your power package.

The power package should be drained before flushing or prior to extended or cold weather storage.

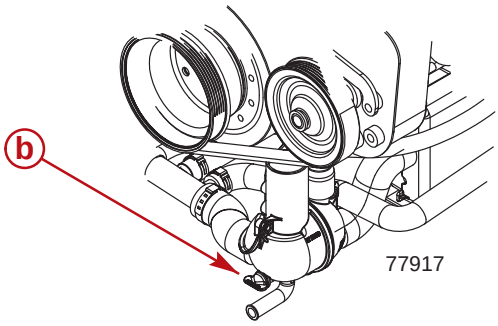
IMPORTANT: The boat must not be operating at any point during this procedure.

Identification

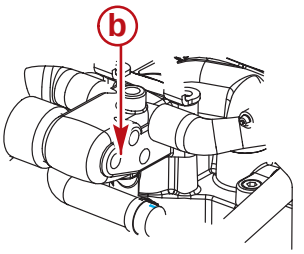
MANUAL SINGLE POINT DRAIN SYSTEM



77947



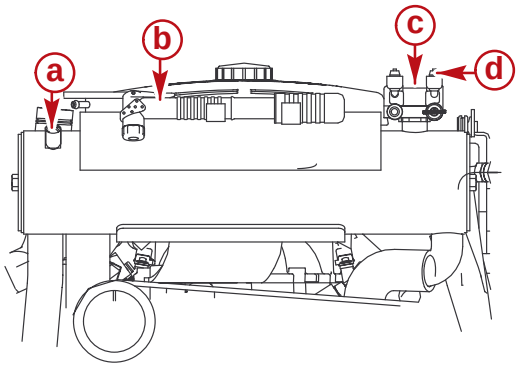
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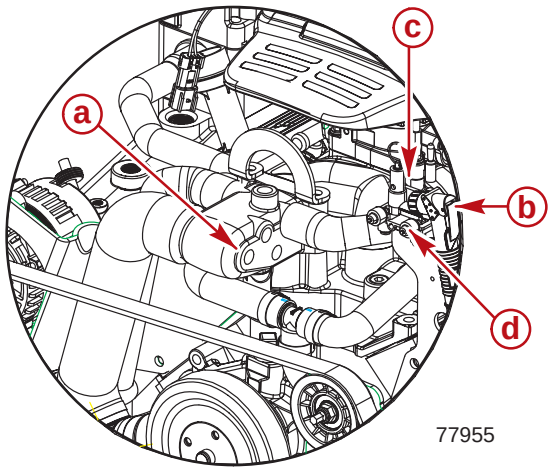
a - Blue Handle
b - Blue Drain Plug Location

AIR ACTUATED SINGLE POINT DRAIN SYSTEM



77955

Closed Cooled Models

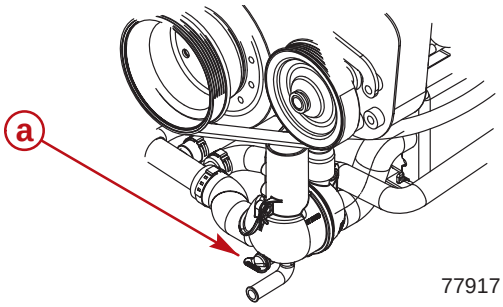


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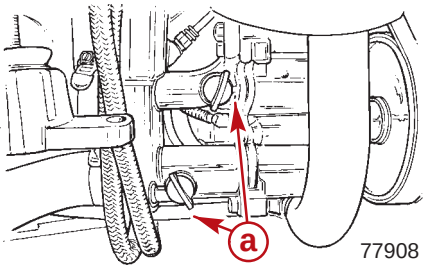
Seawater Cooled Models

a - Blue Drain Plug Location
b - Blue Air Pump
c - Air Manifold
d - Green Indicators

3 POINT MANUAL DRAIN SYSTEM



77917



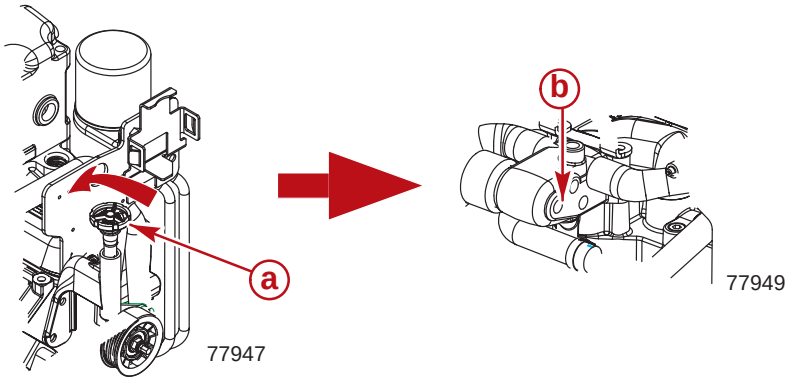
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a - Blue Drain Plug

Boat In The Water

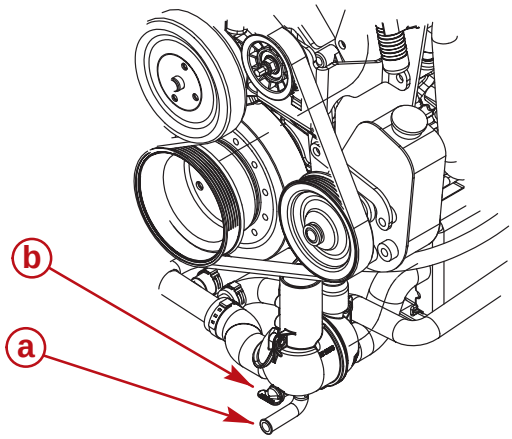
MANUAL SINGLE POINT DRAIN SYSTEM

1. Close the seacock.
2. Rotate the blue handle COUNTERCLOCKWISE until it stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.
3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



a - Blue Handle
b - Blue Drain Plug Location

4. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and drain manually.



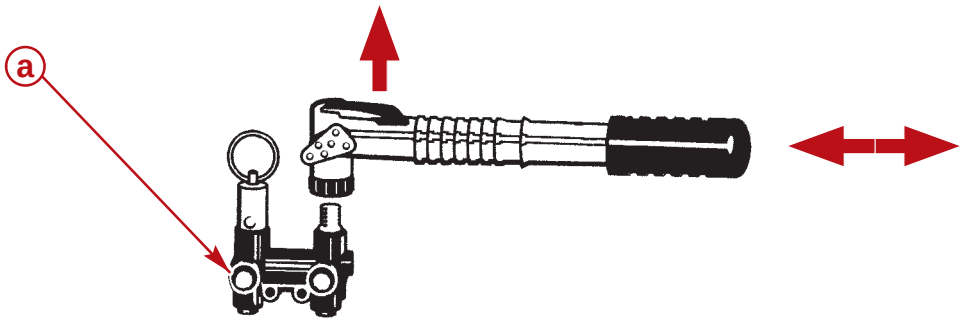
a - Drain Location - Orange Or Red
b - Blue Drain Plug

5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance.
6. Reinstall the blue drain plug in the thermostat housing.
7. Close the drain system by rotating the blue handle CLOCKWISE until it stops and install the blue drain plug, if removed. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.
8. Open the seacock prior to operating the engine.

AIR ACTUATED SINGLE POINT DRAIN SYSTEM

NOTE: *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

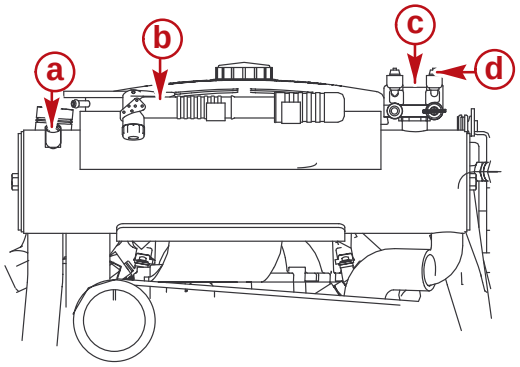
1. Close the seacock.
2. Remove the blue air pump from the engine.
3. Ensure that lever on top of pump is flush with the handle (horizontal).
4. Install the air pump on the fitting in the air manifold.



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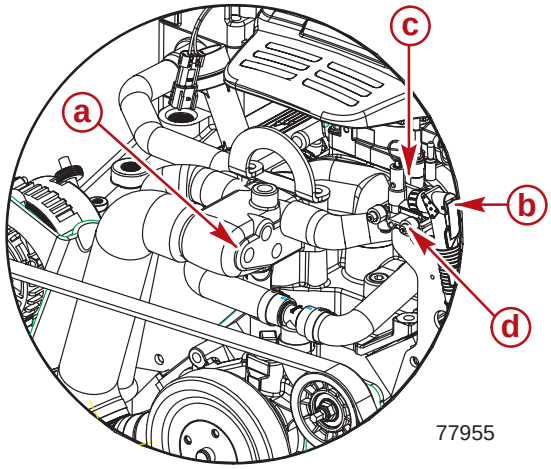
a - Green Indicators

5. Pull lever on the air pump up (vertical) to lock pump on the fitting.
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.
7. **Immediately** remove the blue drain plug from the side of the thermostat housing or the heat exchanger. This must be removed within 30 seconds to properly vent the cooling system.



77955

Closed Cooled Models

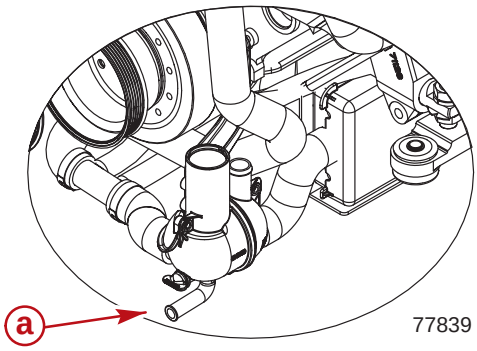


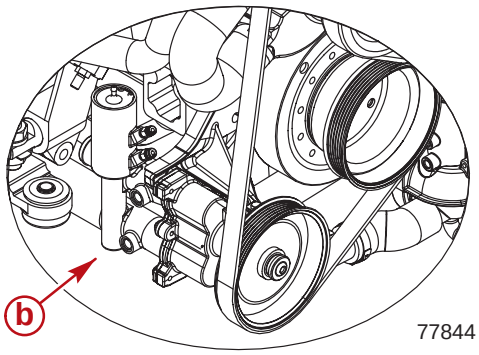
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Seawater Cooled Models

a - Blue Drain Plug Location
b - Blue Air Pump
c - Air Manifold
d - Green Indicators

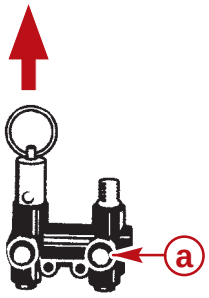
8. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System instructions.





a - Port Side Drain Location
b - Starboard Side Drain Location

9. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
10. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do NOT allow engine to start.
11. Reinstall the blue drain plug in the thermostat housing.
12. Remove the air pump from the air manifold and return it to the mounting bracket.
13. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
14. Before launching boat, pull up on manual release valve. Verify that green indicators are no longer extended.



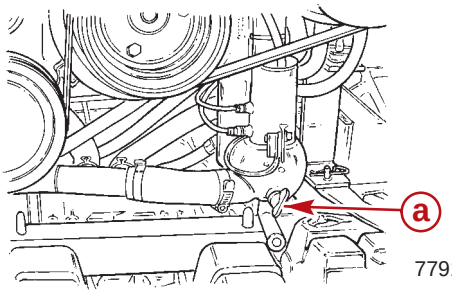
a - Green Indicators

15. Open the seacock prior to operating the engine.

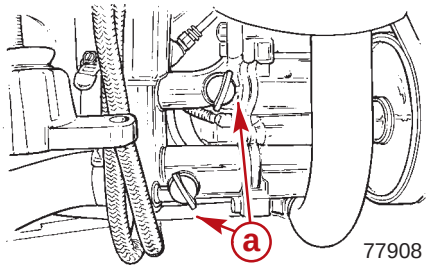
3 POINT MANUAL DRAIN SYSTEM

NOTE: *Use this procedure if your engine is not equipped with an air actuated single point drain system or if the single point drain system fails.*

1. Close the seacock.
2. Remove three blue drain plugs: One from the distribution housing (lower front, port side) and two from the seawater pickup pump (front, starboard side).



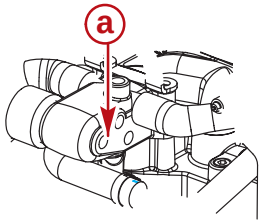
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a - Blue Drain Plugs

3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



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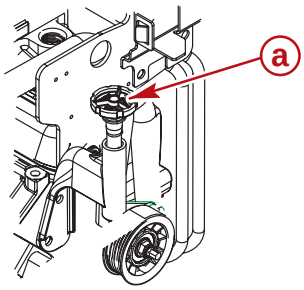
a - Blue Drain Plug Location

4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance.
6. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do NOT allow the engine to start.
7. Prior to launching boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. Open the seacock prior to operating the engine.

Boat Out Of The Water

MANUAL SINGLE POINT DRAIN SYSTEM

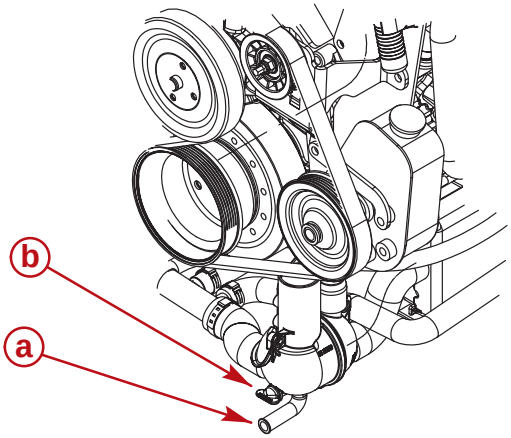
1. Rotate the blue handle COUNTERCLOCKWISE until rotation stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.



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a - Blue Handle

2. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and allow to drain manually.



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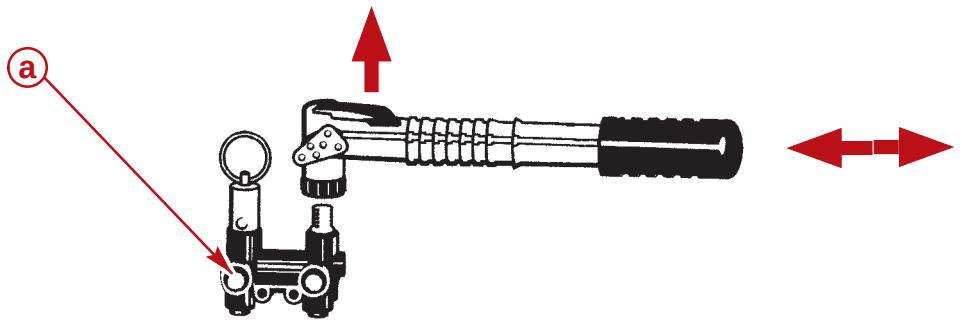
a - Drain Location - Orange Or Red
b - Blue Drain Plug

3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
4. Close the drain system by rotating the blue handle CLOCKWISE until it stops or installing the blue drain plug. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.

AIR ACTUATED SINGLE POINT DRAIN SYSTEM

NOTE: *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

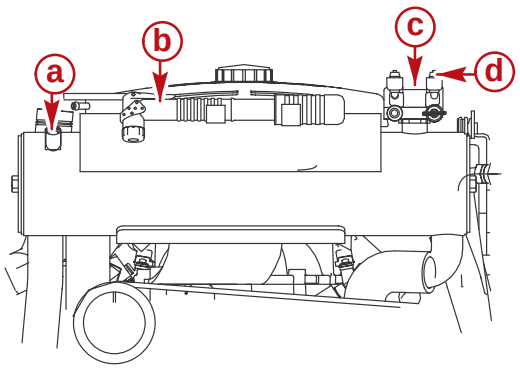
1. Remove the blue air pump from the engine.
2. Ensure that lever on top of pump is flush with the handle (horizontal).
3. Install the air pump on the fitting in the air manifold.



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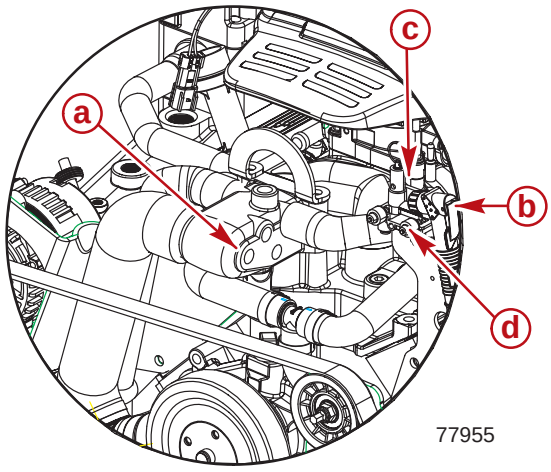
a - Green Indicators

4. Pull the lever on the air pump up (vertical) to lock the pump on the fitting.
5. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



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Closed Cooled Models

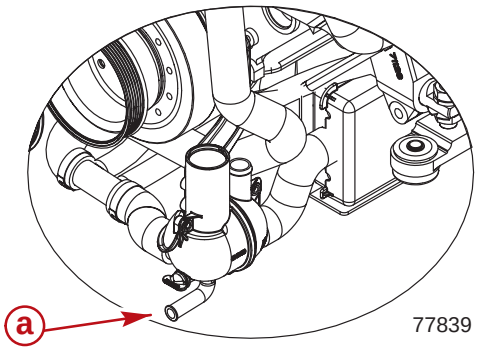


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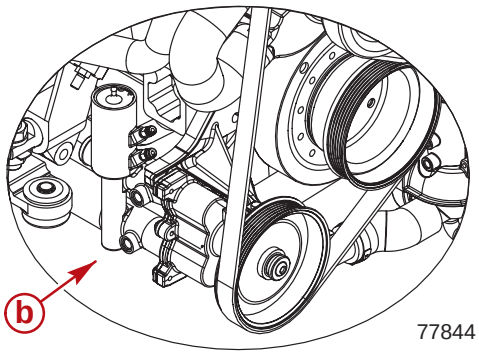
Seawater Cooled Models

a - Blue Drain Plug Location
b - Blue Air Pump
c - Air Manifold
d - Green Indicators

6. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System.



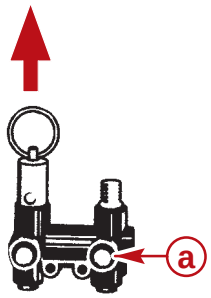
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77844

a - Port Side Drain Location
b - Starboard Side Drain Location

7. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do NOT allow engine to start.
9. Remove the air pump from the air manifold and return it to the mounting bracket.
10. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
11. Before launching boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



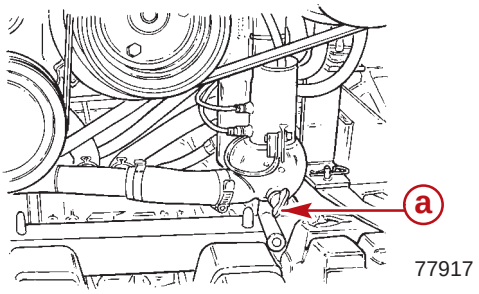
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a - Green Indicators

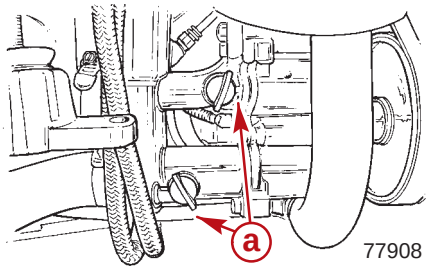
3 POINT MANUAL DRAIN SYSTEM

NOTE: *Use this procedure if your engine is not equipped with an air actuated single point drain system or if the single point drain system fails.*

1. Remove three blue drain plugs: One from the distribution housing (lower front, port side) and two from the seawater pickup pump (front, starboard side).



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77908

a - Blue Drain Plug

2. Verify that water is draining from each opening.
3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
4. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do NOT allow engine to start.
5. Prior to launching boat or starting the engine, close the drain system by re-installing the three blue drain plugs.

All Models

1. For additional assurance against freezing and corrosion, fill the cooling system with a mixture of propylene glycol antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
   a. Remove thermostat housing or hose and fill with propylene glycol coolant until engine block is full. If thermostat housing was removed, reinstall and tighten cover bolts securely.

Store boat with drive unit in full DOWN/IN position.

Recommissioning

NOTICE

Refer to "Cold Weather or Extended Storage Precautions" in this section BEFORE proceeding.

⚠ WARNING

To prevent possible injury or damage to equipment, do not install battery until all maintenance has been performed on engine.

1. Check that all cooling system hoses are connected properly and hose clamps are tight. Check that all drain plugs are installed and tightened securely.
2. Inspect drive belts.

⚠ CAUTION

When installing battery, be sure to connect NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal and POSITIVE (+) battery cable to POSITIVE (+) battery terminal. If battery cables are reversed, electrical system damage will result.

3. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables (see CAUTION listed above). Tighten each cable clamp securely when connecting.
4. Coat terminal connections with a battery terminal anti-corrosion agent.
5. Perform all maintenance tasks listed in the MAINTENANCE SCHEDULES, except those performed during the power package lay up procedure.
6. Perform all checks in the BEFORE STARTING column of the Operation and Maintenance Manual OPERATION CHART.

⚠ CAUTION

Refer to FLUSHING COOLING SYSTEM before starting engine.

7. Supply water to the seawater pickup pump as outlined in "Flushing Cooling System."
8. Start engine and closely observe instrumentation to make sure that all systems are functioning correctly.
9. Carefully inspect engine for fuel, oil, fluid, water and exhaust leaks.
10. Check steering system and shift and throttle controls for proper operation.
11. For drive unit, refer to appropriate sterndrive manual.

NOTES:

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2
A

BATTERIES/WIRING

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Battery Requirements for MerCruiser Products

Battery Ratings

There are two major rating systems used in the USA for marine engine cranking batteries. The most common is cca (cold cranking amps) which rates the cranking amps at 0° F. The second system, mca (marine cranking amps), rates the cranking amps at 32° F. The mca (marine cranking amps) rating of a given battery is always higher than the cca (cold cranking amps) rating. There is a third rating system that some discount stores use which rates the cranking amps of a battery at 80° F. The advertised cranking amps of these batteries is high while the actual cca of it is very low.

Cold Cranking Amps – (CCA)

This figure represents in amps the current flow the battery can deliver for 30 seconds at 0º Fahrenheit without dropping below 1.2 volts per cell (7.2 volts on a standard 12 volt battery). The higher the number, the more amps it can deliver to crank the engine. (CCA x 1.3 = MCA)

Marine Cranking Amps – (MCA)

This figure is similar to the CCA test figure except that the test is run at 32º Fahrenheit instead of “0”. (MCA x .77 = CCA)

This is more in line with actual boat operating conditions.

Reserve Capacity

This figure represents the time in minutes that a fully charged battery at 80º Fahrenheit can deliver 25 amps, without dropping below 1.75 volts per cell (10.5 volts on a standard 12 volt battery). The reserve capacity rating defines the length of time that a typical vehicle can be driven after the charging system fails. The 25 amp figure takes into account the power required by the ignition, lighting and other accessories. The higher the reserve capacity rating, the longer the vehicle could be driven after a charging system failure.

Amp-Hour Rating

The ampere hour rating method is also called the 20 hour rating method. This rating represents the steady current flow that the battery will deliver for 20 hours while at 80º Fahrenheit without dropping below 1.75 volts per cell (10.5 volts on a standard 12 volt battery). The rating is actually the steady current flow times the 20 hours. Example: A 60 amp-hour battery will deliver 3 amps continuously for 20 hours.

The following battery charts list the minimum cca, mca and Ah (Amp hour) ratings required for use on MerCruiser products. The Amp hour rating is used outside the USA and Canada.

GASOLINE ENGINES

Engine	CID (L)	Minimum Required Cranking Battery Size
4 4 V6 6 V8 V8 V8 Carb V8	153 (2.5) 181 (3.0) 229 (3.8) 250 (4.0) 302 (5.0) 305 (5.0) 350 (5.7) 351 (5.8)	375 cca or 475 mca or 90 Ah
4 V6 V8 V8 Carb	224 (3.7) 262 (4.3) 427 (7.0) 454 (7.4)	450 cca or 575 mca or 90 Ah
V8 V8 Carb V8	482 (7.9) 502 (8.2) 540 (8.9)	550 cca or 700 mca or 120 Ah
V8 Carb	572 (9.4)	600 cca or 750 mca or 150 Ah
All EFI and MPI Models		750 cca or 950 mca or 180 Ah

DIESEL ENGINES

Engine	CID (L)	Minimum Required Cranking Battery Size
4 4 5 6 6 V8	103 (1.7) 169 (2.8) 183 (3.0) 219 (3.6) 254 (4.2) 444 (7.3)	750 cca or 950 mca or 180 Ah

Battery Cables - Length and Size

NOTE: *Battery should be located as close to engine as possible.*

1. Select proper size positive (+) and negative (–) battery cables using the chart.
   a. Add the positive and negative cable lengths together.
   b. Divide by 2 to obtain the average cable length.

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do NOT use acid flux solder, as it may cause corrosion and a subsequent failure.

IMPORTANT: Tapered post connectors with wing nut connections can be used. The tapered posts must be used for the engine battery cables. The wing nut connections should be used only for the power trim pump and accessories. It is recommended that the wing nuts be replaced with regular nuts to ensure that the connections are tightened securely.

GASOLINE ENGINES

Battery Cable Length	Minimum Cable Gauge
Up to 3-1/2 ft. (1.1 m)	4 (25mm^2)
3-1/2 - 6 ft. (1.1 - 1.8 m)	2 (35mm^2)
6 - 7-1/2 ft. (1.8 - 2.3 m)	1 (50mm^2)
7-1/2 - 9-1/2 ft. (2.3 - 2.9 m)	0 (50mm^2)
9-1/2 - 12 ft. (2.9 - 3.7 m)	00 (70mm^2)
12 - 15 ft. (3.7 - 4.6 m)	000 (95mm^2)
15 - 19 ft. (4.6 - 5.8 m)	0000 (120mm^2)

DIESEL ENGINES

Battery Cable Length	Minimum Cable Gauge
Up to 3 ft. (0.9m)	2 (35mm^2)
3 - 3-3/4 ft. (0.9 - 1.1m)	1 (50mm^2)
3-3/4 - 4-3/4 ft. (1.1 - 1.4m)	0 (50mm^2)
4-3/4 - 6 ft. (1.4 - 1.8m)	00 (70mm^2)
6 - 7-1/2 ft. (1.8 - 2.3m)	000 (95mm^2)
7-1/2 - 9-1/2 ft. (2.3 - 2.9m)	0000 (120mm^2)
9-1/2 - 12 ft. (2.9 - 3.7m)	• 00 (70mm^2)
12 - 15 ft. (3.7 - 4.6m)	• 000 (95mm^2)
15 - 19 ft. (4.6 - 5.8m)	• 0000 (120mm^2)

- Two cables of specified gauge required for positive and two required for negative.

With the old battery cable recommendation, the negative (–) and the positive (+) battery cables were measured separately and then select the correct cable gauge to fit the length measured for each. This was OK if they were both the same length. It did not work well if there was a battery switch installed in the positive (+) battery cable between the engine and battery. Then, the positive (+) cable had to use a much larger gauge than the negative (–) did. In the example below, this would have meant the shorter 36 in. (91.4 cm) length negative (–) would have used a 4 ($25mm^2$) gauge cable. The longer 228 in. (579.1 cm) positive (+) cable would have used 0000 ($120mm^2$) gauge.

EXAMPLE: A person measures 36 in. (91.4 cm) length of negative (–) cable between engine and battery. They measure 108 in. (274.3 cm) of positive (+) cable between the engine and the battery switch and 120 in. (304.8 cm) between the battery switch and battery. Add 36 in. (91.4 cm) + 108 in. (274.3 cm) + 120 in. (304.8 cm) = 264 in. (670.5 cm) divide by 2 = 132 in. (335.3 cm) or 11 ft. (3.4 m). So BOTH the negative (–) AND positive (+) battery cable use the 00 ($70mm^2$) gauge cable.

By using the same gauge battery cable, 00 ($70mm^2$) gauge in the example above, for BOTH the negative (–) and positive (+) cable, the longer length positive (+) cable can use a smaller gauge cable than it would have if the negative (–) and positive (+) gauges were sized to their respective lengths.

Battery Testing

Hydrometer Tests:

A fully charged battery will read between 1.225 and 1.280 at 80º Fahrenheit. Readings of 1.225 and lower will require recharging & retesting. All cells should read within 30 points of each other. You must correct the Hydrometer reading for Ambient Temperature.

CAPACITY TESTS:

(The Specific Gravity must be 1.225 or higher before continuing)

Variable Load High Rate Discharge Tester (Recommended): Discharge the battery with a load bank (carbon pile) set to 1/2 the CCA Rating or 3 times the Amp–Hour Rating for 15 Seconds, at the end of the 15 second period the battery voltage must be 9.6 volts or higher*.

Fixed Resistance: This equipment has built–in load for high–rate discharge testing. Follow equipment manufacturer's instructions regarding test period and meter readings.

Cranking Discharge Method: With a Voltmeter attached to the battery, Crank the engine for 15 seconds, the battery voltage must be 9.6 Volts or higher* at the end of the 15 second period.

* Lower ambient temperature readings (below 70º Fahrenheit) will result in lower voltage readings.

0ºF	10ºF	20ºF	30ºF	40ºF	50ºF	60ºF
8.5v	8.7v	8.9v	9.1v	9.3v	9.4v	9.5v

Charging Guide

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/2 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

* Initial rate for constant voltage taper rate charger

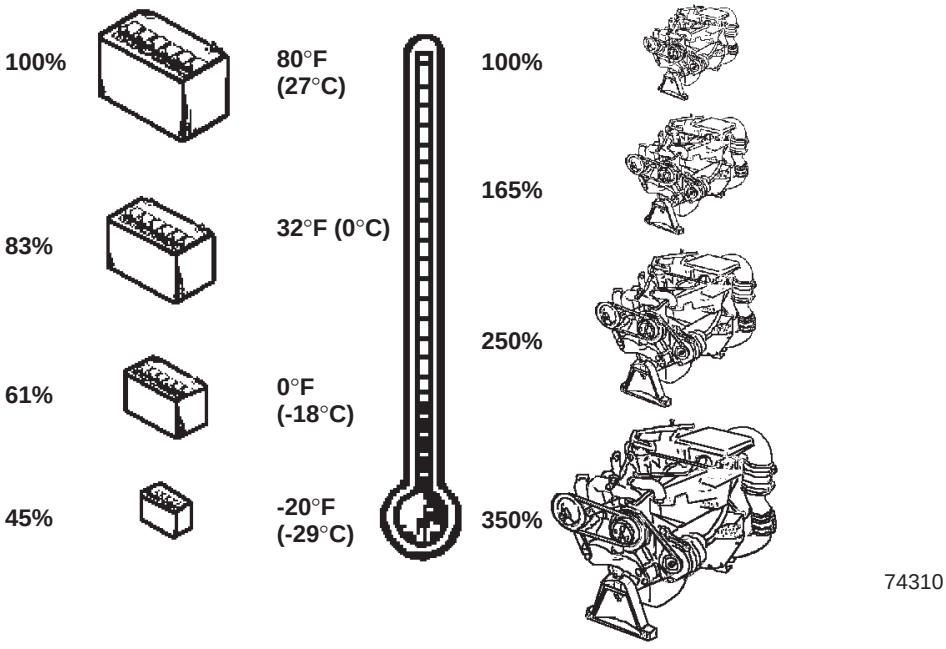
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

Battery Power as Affected by Temperature



Power (Watts) Available **Power (Watts) Required**

NOTES:

Wiring Colors for MerCruiser

NOTE: *Color codes listed below DO NOT apply to fuel injection system harnesses.*

NMMA COLOR CODE AND ABBREVIATIONS	WHERE USED
BLACK (BLK)	All Grounds
BROWN (BRN)	Reference Electrode - MerCathode
LT. BLUE/WHITE (LT BLU/WHT)	Trim - “Up” Switch
GRAY (GRY)	Tachometer Signal
GREEN/WHITE (GRN/WHT)	Trim - “Down” Switch
TAN (TAN)	Water Temperature Sender to Gauge
LIGHT BLUE (LT BLU)	Oil Pressure Sender to Gauge
PINK (PNK)	Fuel Gauge Sender to Gauge
BROWN/WHITE (BRN/WHT)	Trim Sender to Trim Gauge
PURPLE/WHITE (PUR/WHT)	Trim - “Trailer” Switch
RED (RED)	Unprotected Wires from Battery
RED/PURPLE (RED/PUR)	Protected (Fused) Wires from Battery
RED/PURPLE (RED/PUR)	Protected (+12V) to Trim Panel
ORANGE (ORN)	Alternator Output / Anode Electrode - MerCathode
PURPLE/YELLOW (PUR/YEL)	Bypass-Ignition / Electric Fuel Pump*
PURPLE (PUR)	Ignition Switch (+12V)
YELLOW/RED (YEL/RED)	Starter Switch to Starter Solenoid to Neutral Start Switch
TAN/BLUE (TAN/BLU)	Audio Warning System

* Also Electric Chokes on models so equipped

NOTE: *Yellow used as GROUND wire color in Europe and by some North American Boat-builders.*

NOTES:

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. Before component replacement and/or during normal troubleshooting procedures, visually inspect any questionable mating connector. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

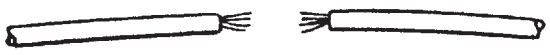
Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers.

Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

Wire Repair

1. Locate damaged wire.
2. Remove insulation as required.



73048

3. Splice two wires together using splice clips and rosin core solder.



73048

4. Cover splice with heat shrink sleeve to insulate from other wires.



73048

Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt that could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

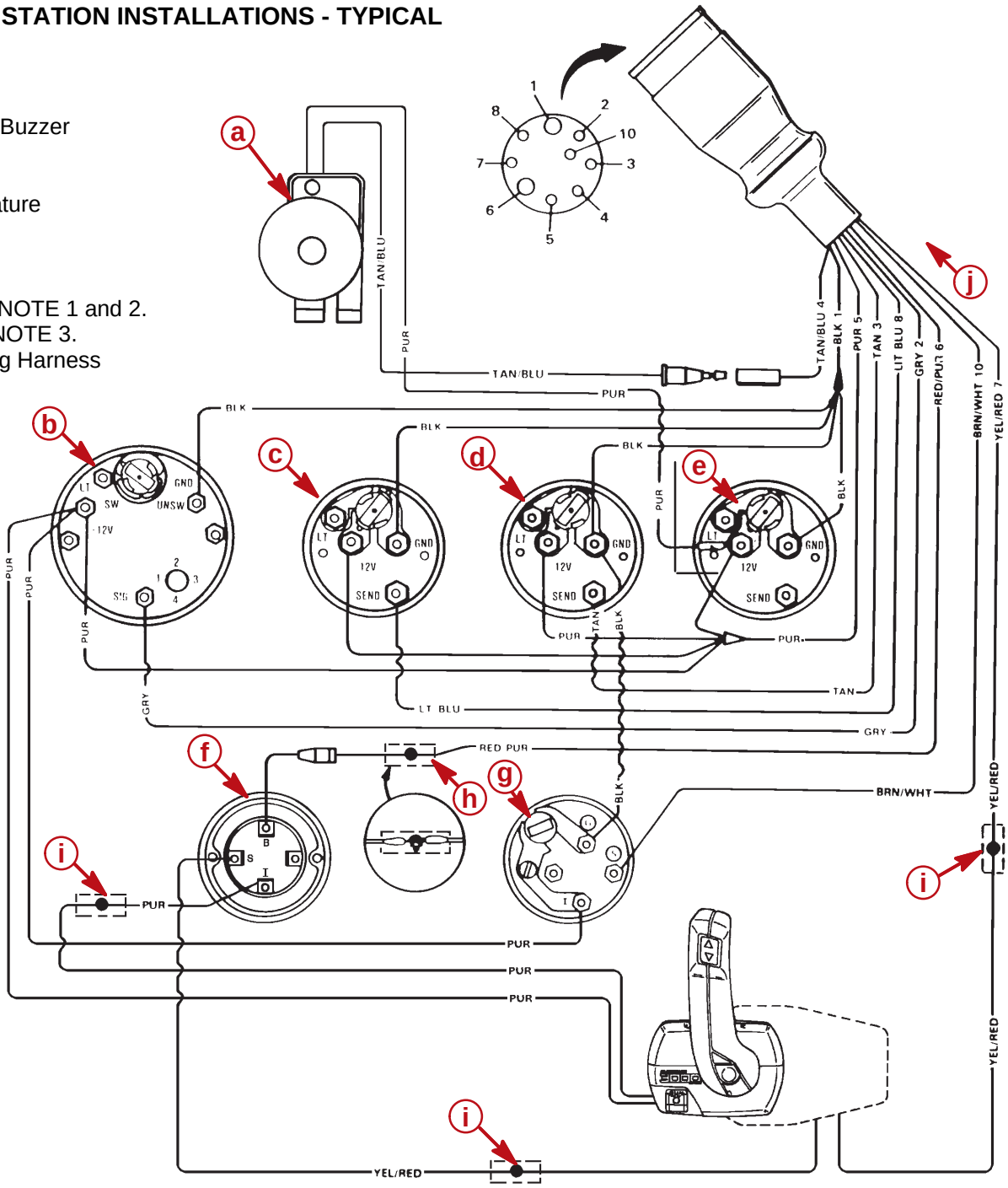
Wiring Diagrams

Quicksilver Instrumentation Wiring Diagrams - MCM Gasoline Engine

SINGLE STATION INSTALLATIONS - TYPICAL

a - Audio Warning Buzzer
b - Tachometer
c - Oil Pressure
d - Water Temperature
e - Battery Meter
f - Ignition Switch
g - Trim Indicator
h - Read/Observe NOTE 1 and 2.
i - Read/Observe NOTE 3.
j - To Engine Wiring Harness

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT OR LT = LIGHT
DRK = DARK



74583

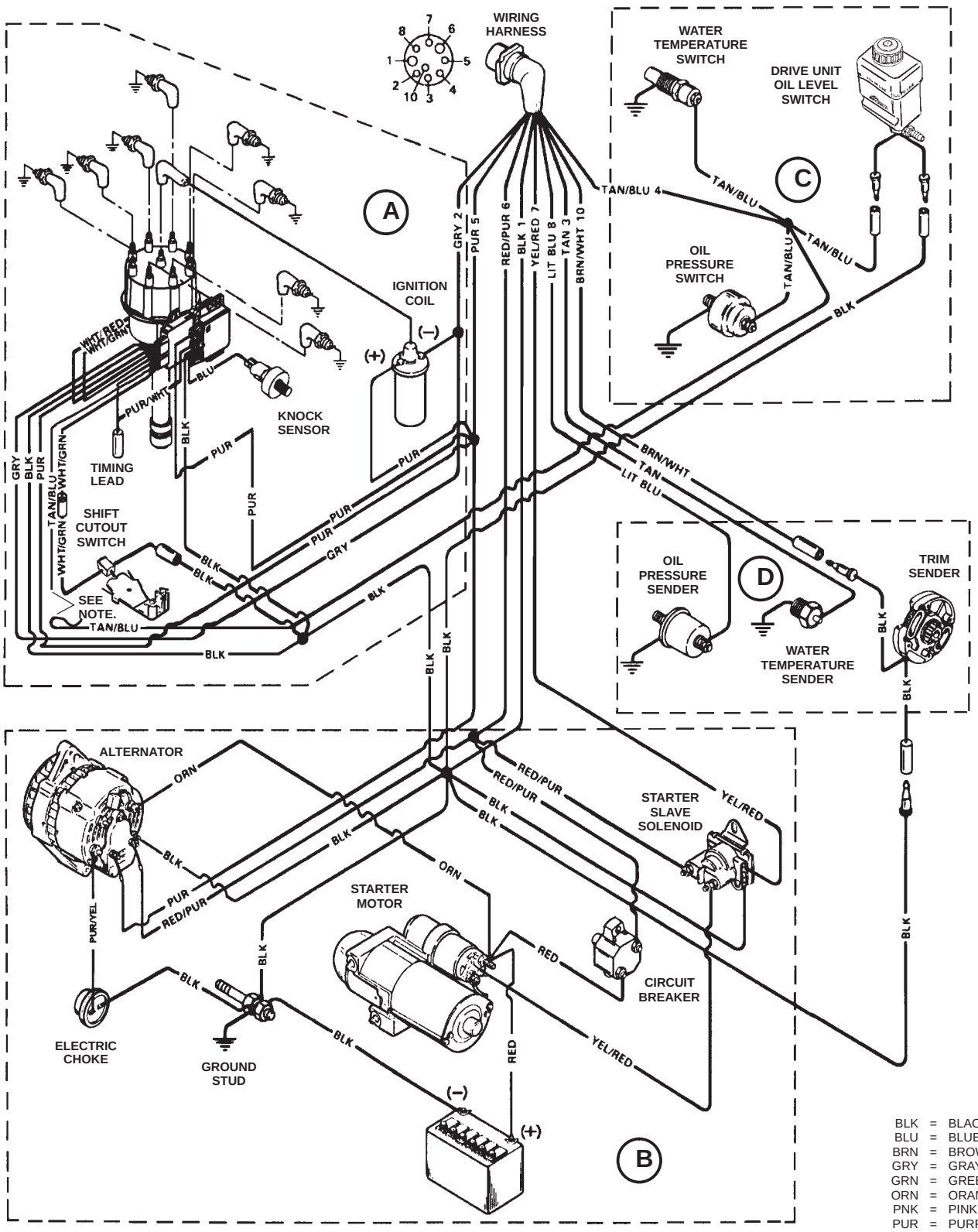
Refer to gauge manufacturer's instructions for specific connections.

NOTE: 1 Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleeve over Connection.

NOTE: 2 Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire Must Be Connected to Instrument Terminal That Has an 8-Gauge Black (Ground) Harness Wire Connected to it.

NOTE: 3 Lanyard stop switch lead and neutral safety switch leads must be soldered and covered with shrink tube for a water proof connection. If an alternate method of connection is made, verify connection is secure and sealed for a water proof connection.

5.7LX/350 Magnum Alpha Engines - Thunderbolt V Ignition With Knock Sensor



BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK

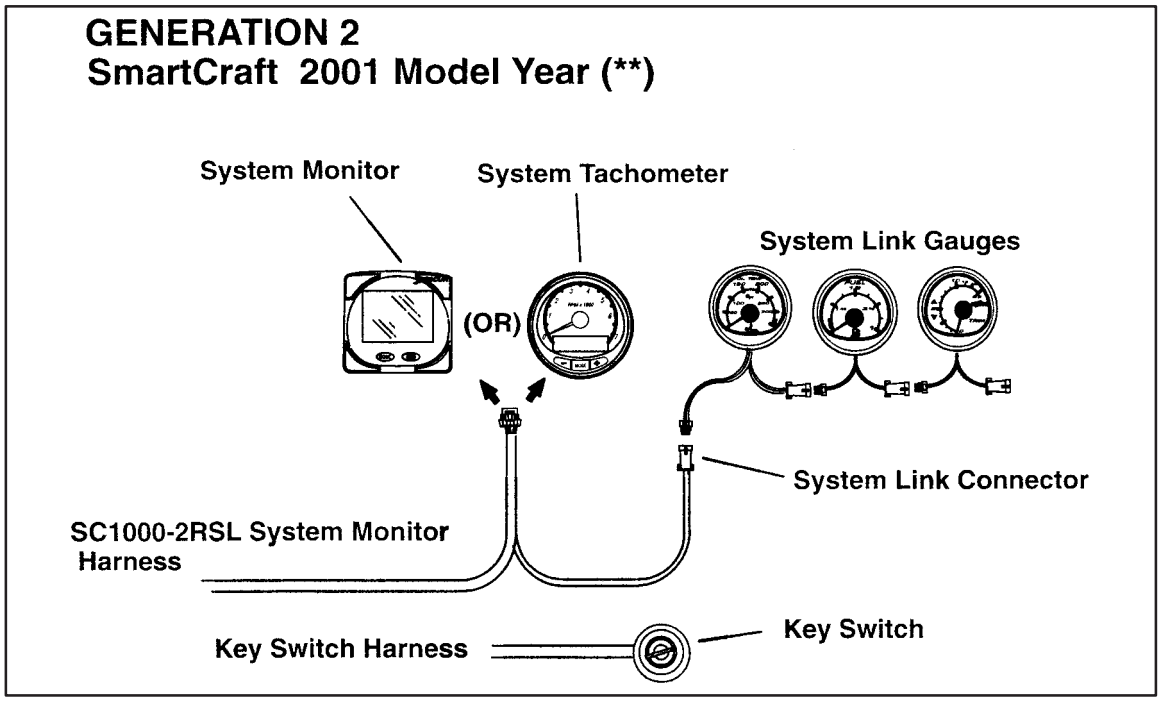
A: Ignition Components
B: Starting, Charging and Choke Components
C: Audio Warning Components
D: Instrumentation Components

NOTE: *TAN/BLU Wire not used at distributor.*

75120

SmartCraft Product Rigging Components

Typical System Layouts – Single Engine Product Configurations



* Generation 1 supports SmartTach and SmartSpeed on Optimax engines only.

** Generation 2 supports all “System” products, System Tach/Speed, System Monitor and System View on all engines after and including the 2001 model year.

NOTE: *Additional products will be compatible with System Tachometer and System Speedometer. Contact your Mercury Marine Sales Department for additional SmartCraft product compatibility and availability.*

V-6 and Small Block V-8 Electric Fuel Pump Used on Carbureted Models

For engine starting and running the electric fuel pump uses two electric circuits. These two circuits are designed to prevent the fuel pump from running if the key is accidently left on.

A jumper wire connects one side of the oil pressure switch to the electrical harness. The purple wires in the harness are supplied current when the key switch is in the run position. When the engine is running, oil pressure (4 psi) holds the contacts inside the oil pressure switch closed. Current will pass through the closed contacts and on to the purple/yellow wire, connecting to the fuel pump.

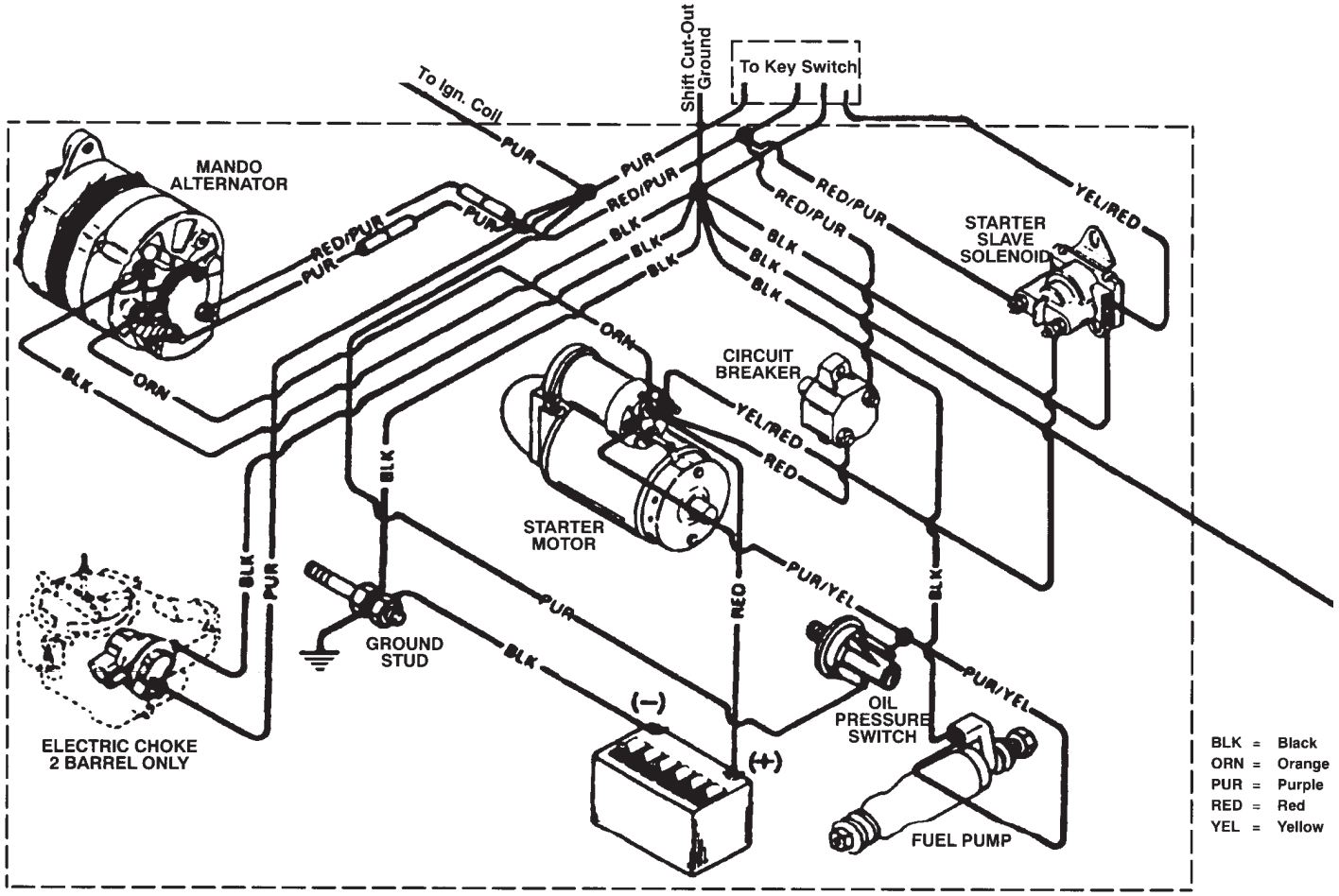
During starting; the oil pressure switch is open due to little or no oil pressure. To engage the starter, the starter solenoid is activated by current through the yellow/red wire. With the solenoid activated, a metal disk inside the solenoid connects the positive battery terminal to the purple/yellow wire. This connection bypasses the oil pressure switch and supplies current to the fuel pump.

Fuel Pressure 3 - 9 psi

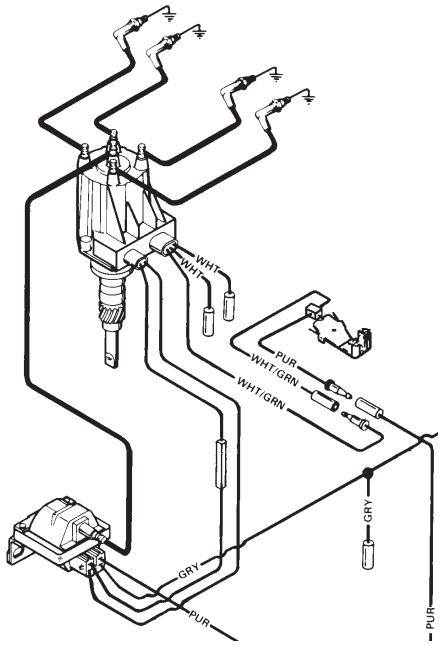
Electric Fuel Pump RFI Filter Replacement S/B 92-15

Sticking Fuel Pump Check Valves S/B 98-4

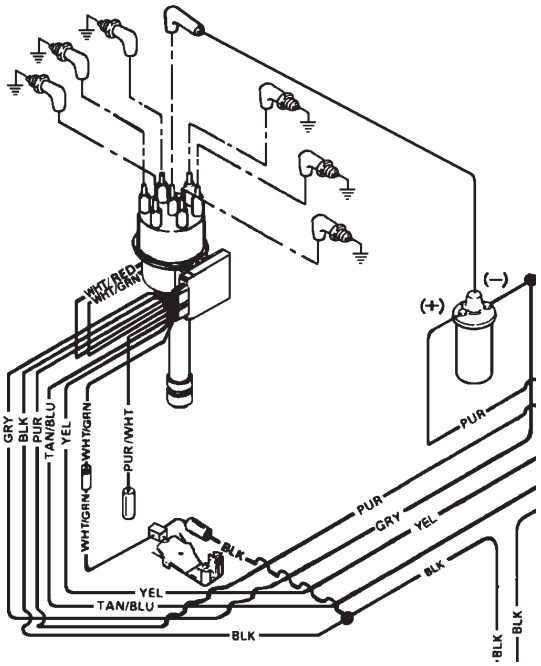
Gasoline Additive Problems S/B 98-5



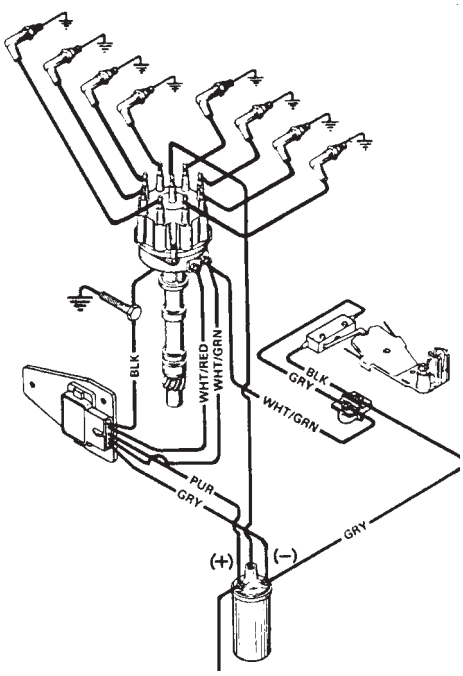
Shift Switch Operation



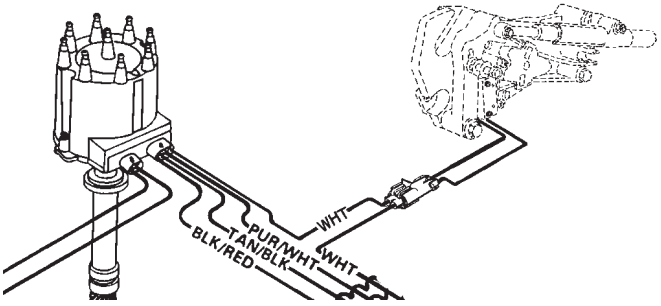
3.0 Litre with EST – Run Position - Normally Open (No Continuity)



Thunderbolt V – Run Position - Normally Open (No Continuity)



Thunderbolt IV – Run Position - Normally Open (No Continuity)

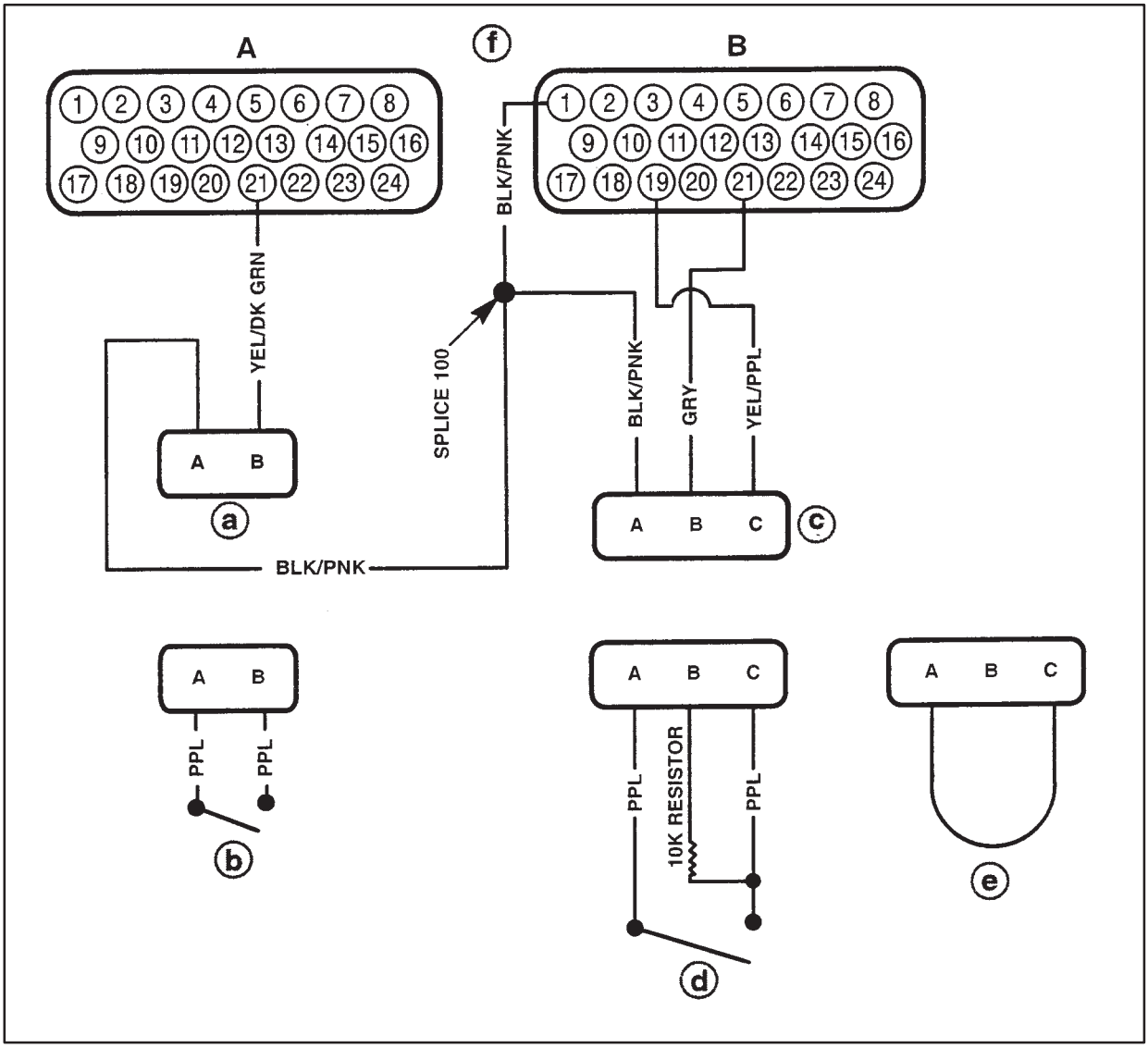


Alpha EFI Models – (MEFI 1 Shown)
Run Position - Normally Closed (Continuity)

MEFI 1 – Switch is in EST circuit

MEFI 2/3 – Switch wired directly to the ECM

ECM 555 Gear Indicator, Shift Interrupt



a - Gear Indicator

b - Gear Indicator Switch –
Closed in Neutral
Open in Gear
Normally Closed Switch

c - Shift Interrupt Switch

d - Shift Interrupt Switch (Alpha Models)

A to C	Normally Closed
A to C	Open When Activated
A to B	10K Ω Rekeased
A to B	∞ When Activated
B to C	Always 10K Ω

e - Jumper Plug (Bravo Models)

f - ECM 555

NOTES:

Revised June 1999. Information underlined is new.

Multiple EFI Engine Battery Precautions

Models

MCM, MIE Engines with Electronic Fuel Injection.

Situation

Alternators: They are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine boat operation, an electrical onboard device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the idle alternator on the other engine may now start charging and this could cause a voltage 'spike' in the engine's electrical system. In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM resets itself. The engine will now run normally. This ECM shut down usually happens so fast that the engine just appears to have an 'ignition miss'.

Recommendations

Batteries: Boats with multi-engine EFI power packages require each engine to be connected to its own battery. This ensures that the engine's Electronic Control Module (ECM) has a stable voltage source.

Battery Switches: While engines are running, battery switches should be positioned so each engine is running off its own individual battery. DO NOT run engines with battery switches in "BOTH" or "ALL" position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

NOTE: *Sure Power Industries Inc., Model 32023A meets this design specification.*

1. The boat may have 2 engines connected to a single Model 32023A battery isolator.
2. The Model 32023A battery isolator is connected to 2 banks of batteries.
3. Each bank contains 2 batteries with the cranking battery for 1 engine in each bank.
4. The second battery in each bank is connected in parallel to the cranking battery.
5. The Model 32023A battery isolator is designed for this type of use; 2 battery banks, 2 charging sources, 120 amps (maximum alternator output).
6. When the engines are running, either engine's alternator could be charging either bank of batteries through the Model 32023A battery isolator.

Any other manufacturer's battery isolator that is the same type as the Sure Power Inc., Model 32023A could also be used.

Generators: The generator's battery should be considered in the same manner as another engine's battery.

Service/Repair Of Electrical Test Equipment

All electrical test equipment must be returned to the vendor or repair facility for service repair and/or replacement parts. Please contact the business prior to shipping the unit to obtain shipping, estimates and repair details. Any test equipment received in Fond du Lac or Stillwater will be returned to the sender. The addresses and phone numbers are as follows:

Test Equipment

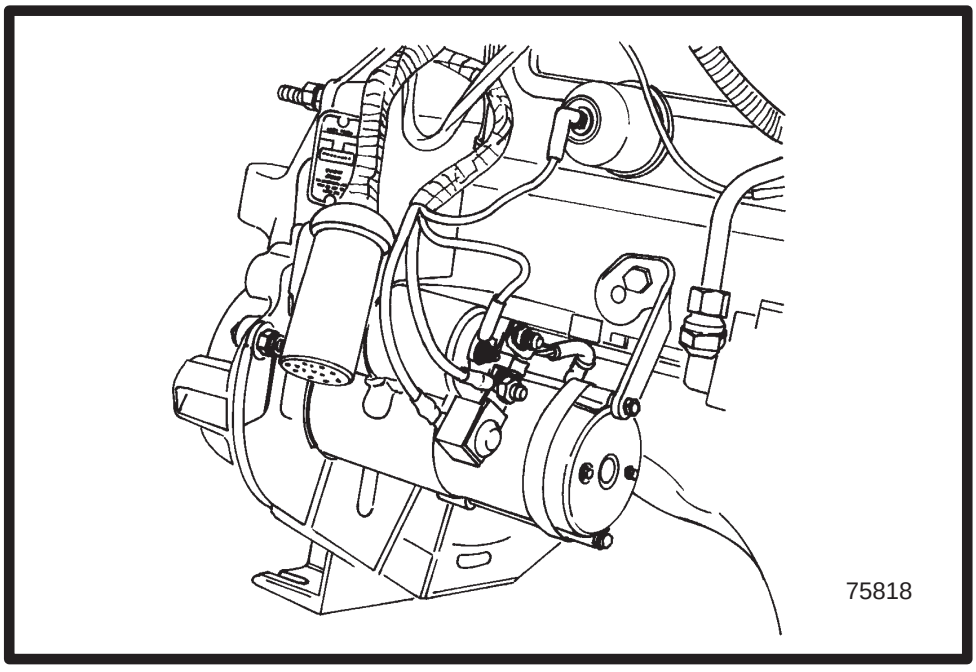
1. Digital Diagnostic Tester (DDT) 91-823686A2
   Vendor: SPX Service Repair
   2300 Park Drive
   Owatonna, MN 55060
   Phone: 800-344-4013
2. Tach/Dwell Meter 91-59339
   Ignition Analyzer 91-76032
   Vendor: Merc-O-Tronic Service Dept.
   215 Branch
   Almont, MI 48003
   Phone: 810-798-8555
   Fax: 810-798-2222
3. Timing Light (self contained) . . 91-99379
   Multi-Meter/DVA 91-99750
   Merctach Digital Tachometer . 79-17391A1
   EFI Tester.(a) 91-11001A2
   Vendor: Electronic Specialties, Inc.
   2449 Pierce Drive
   Spring Grove, IL 60081
   Phone: 815-675-1812
   Fax: 815-675-2905
4. Thunderbolt Ignition Analyzer . 91-62563A1
   VOA Meter 91-62562
   Mark I Tester 91-64645A1
   Vendor: Not Repairable: Replacement parts are not available

a. EFI Tester: Digital Volt Meter is not repairable. Buy a new digital volt meter locally. Meter must be of good quality with at least 10 meg ohms input impedance or it may not allow the EFI Tester to normalize.

NOTES:

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2
B



STARTING SYSTEM

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Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided.

Maintenance

⚠ WARNING

Do not use jumper cables and a booster battery to start engine. Do not recharge a weak battery in the boat. Remove battery and recharge in a ventilated area away from fuel vapors, sparks or flames.

⚠ WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent cell caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion that may shatter the battery and could cause blindness or other serious injury.

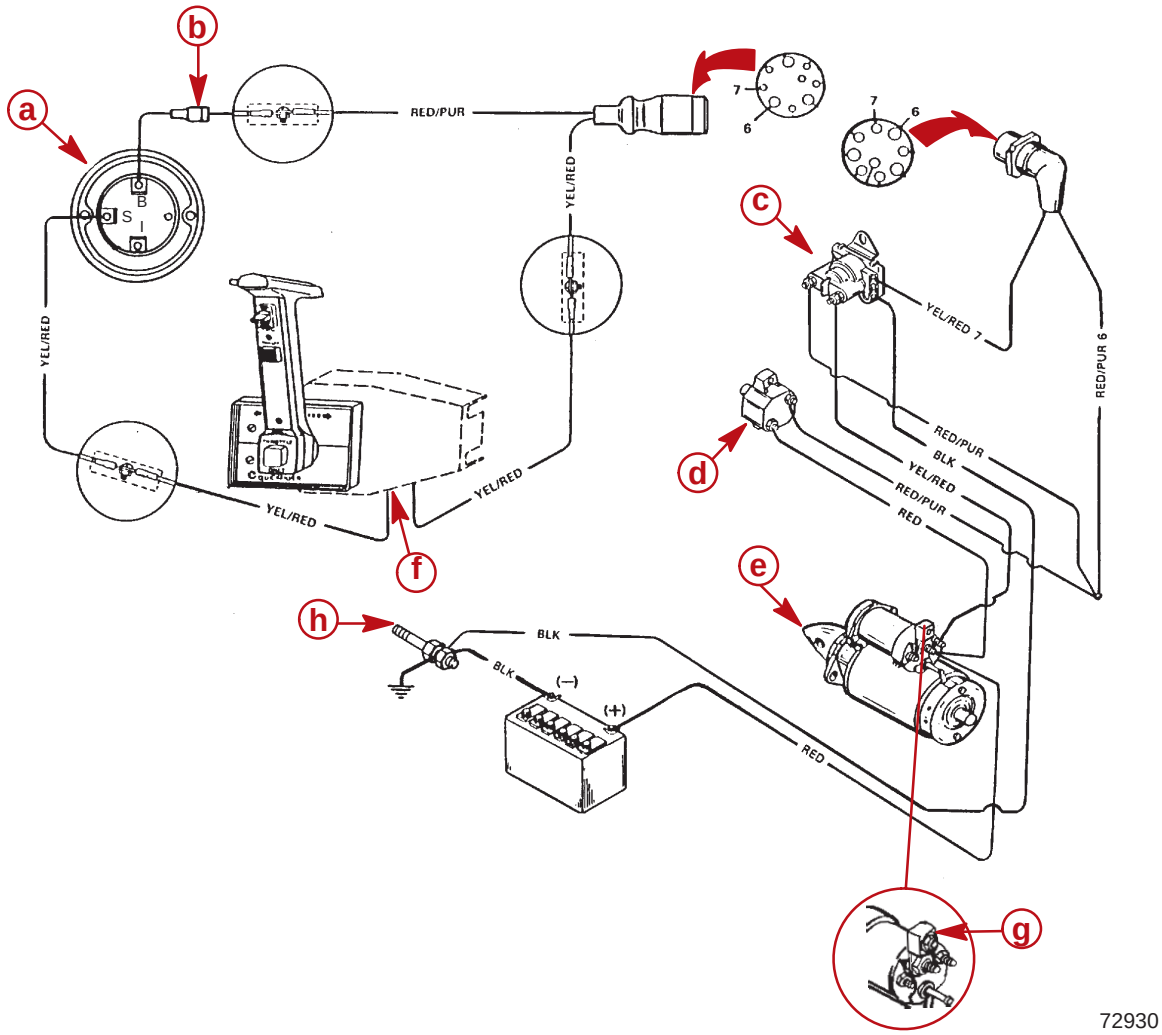
Safety glasses and rubber gloves are recommended when handling batteries or filling with electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where battery is located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

⚠ CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

- **When installing battery, be sure to connect the POSITIVE (+) battery cable to POSITIVE (+) battery terminal first and then the NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal.**
- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

Typical Starting System Components



a - Ignition Switch
b - 20 Amp Fuse
c - Starter Slave Solenoid
d - Circuit Breaker
e - Starter Motor
f - Neutral Safety Switch
g - 90 Amp. Fuse
h - Engine Ground (–)

Starting Circuit Positive Current Flow

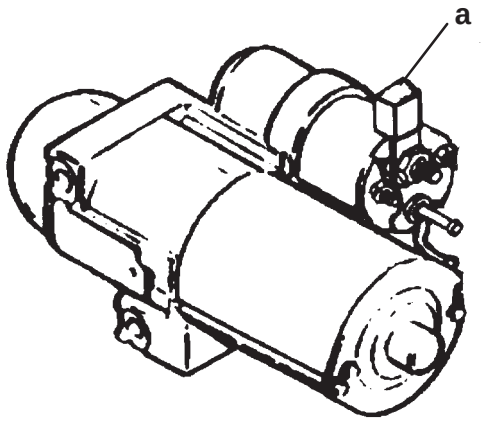
This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch (on starter) [e] to circuit breaker [d] (RED).
- Circuit breaker to wire junction (RED-PUR).
- Wire junction to wiring harness plug (RED-PUR) terminal 6.
- Wiring harness plug to 20 amp fuse [b] (RED-PUR).
- 20 amp fuse to ignition switch terminal B (RED-PUR). At this point ignition switch is turned to START.
- Ignition switch terminal B to terminal S.
- Ignition switch terminal S to neutral start (safety) switch [f] (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION TO START.
- Neutral start (safety) switch [f] to wiring harness plug terminal 7 (YEL-RED).
- Wiring harness plug to starter slave solenoid [c] (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.
- Starter slave solenoid (c) is now “closed,” completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing current to flow to solenoid switch on starter motor [e]; which causes starter motor to crank.

55 Amp Fuse Replaces Circuit Breaker

A 55 Amp fuse is used on 1998, and later, 3.0L, 4.3L and 5.0L Alpha packages, in place of a 55 Amp circuit breaker. The fuse is located on the large terminal of the starter motor and the RED/PUR harness wire connects to it. If you find that the engine’s electrical system is not functioning, check the fuse first. Do not use a higher amperage fuse in place of the 55 Amp part. This fuse is matched to the engine harness wire gauge.

55 Amp Fuse - P/N 88-79023A56



a - 55 Amp Fuse

NOTE:

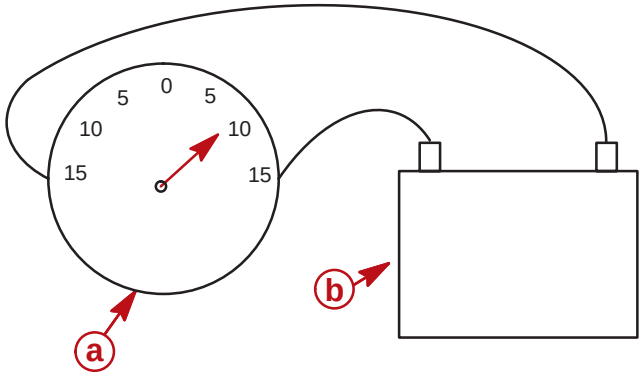
Current carbureted engines use a 55 amp BLACK fuse.

EFI engines use a 90 amp WHITE fuse.

Do not substitute wrong fuse.

Testing

A strong battery must be maintained. If battery shows less than 9-1/2 volts when under starting load, (at 80° F or 27° C) it should be recharged. Check with DC voltmeter.



74307

a - Voltmeter
b - Battery

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

- Battery must be 60 to 100°F (16 to 38°C).
- Electrolyte level must be correct in all cells.
- Battery must be at least half charged.
- No obvious defects.

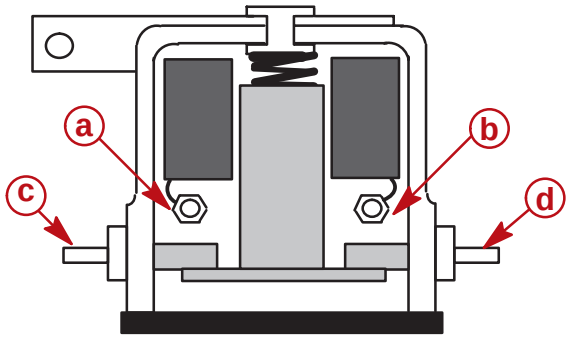
1. Check voltage per manufacturer's specifications.
2. If readings are low, recharge and retest.
3. If readings remain low, battery should be replaced.

Slave Solenoid Identification

Types

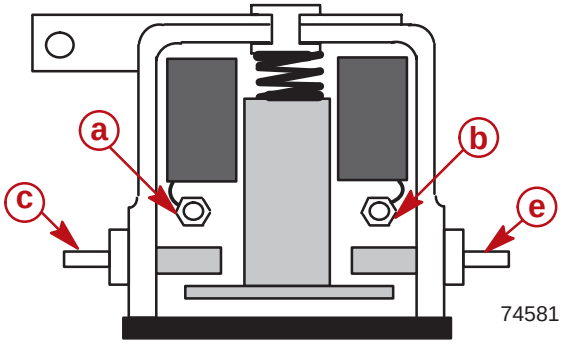
There are two types of slave solenoids (“standard” or “switch”) used on MerCruiser engines. These engines use a standard type solenoid; **do not substitute a switch type solenoid.** The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the “switch type” solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement.

Standard Type Slave Solenoid



Starting Position

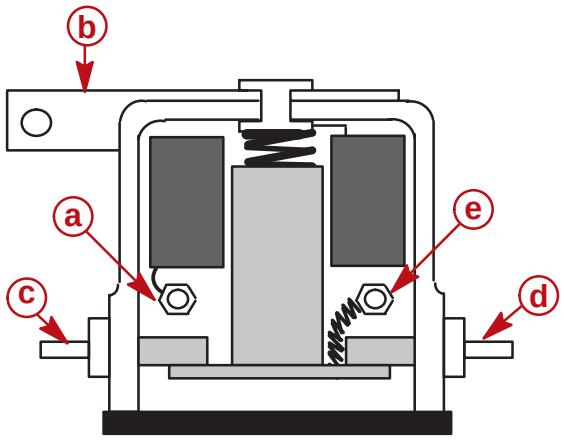
a. From Key Switch (12 Volts In Start Position)
b. To Ground
c. 12 Volts From Battery
d. 12 Volts To Starter



Off or Run Position

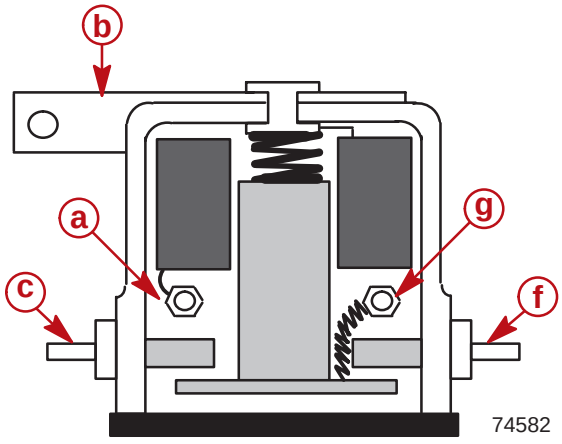
a. 0 Volts From Key Switch
b. To Ground
c. 12 Volts From Battery
e. 0 Volts To Starter

Switch Type Slave Solenoid



Starting Position

a. From Key Switch (12 Volts In Start Position)
b. Mounting Bracket and Ground
c. 12 Volts From Battery
d. 12 Volts To Starter
e. 12 Volts to Ignition Coil

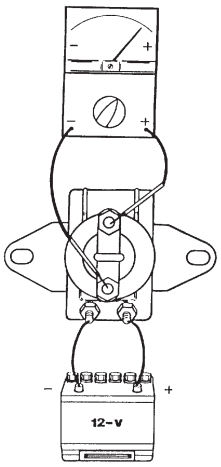


Off or Run Position

a. 0 Volts From Key Switch
b. To Ground
c. 12 Volts From Battery
f. 0 Volts To Starter
g. 0 Volts To Coil

Testing/Replacement

1. Using continuity meter, connect test leads as shown and connect 12-volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Solenoid Switch

The solenoid switch, along with plunger, return spring, and shift lever, are completely sealed and permanently mount-ed in the drive housing. If solenoid is defective, entire drive housing must be replaced.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Delco PG260 Starter Motor

Starter Specifications

Delco I.D. Number	MerCruiser Part Number
9000821	50-806964

Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
	Volts	Min. Amps	Max. Amp	Min. rpm	Max. rpm	
LH	10.6	60	95	2750	3250	83-104 (2352- 2948)
Pinion Clearance	.101 - .160 in. (.025 - 4.06mm)					
Bearing Depth (Gear)	.014 (.038mm) Maximum					
Bearing Depth (Housing)	.017 (0.4mm) Maximum					

Torque Specification

Description	lb-ft	Nm
Starter Motor to Block	30	41
All Other Fasteners	Tighten Securely	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3

NOTE: *The PG260 starter cannot be rebuilt. The only replacement components available are the solenoid and drive housing.*

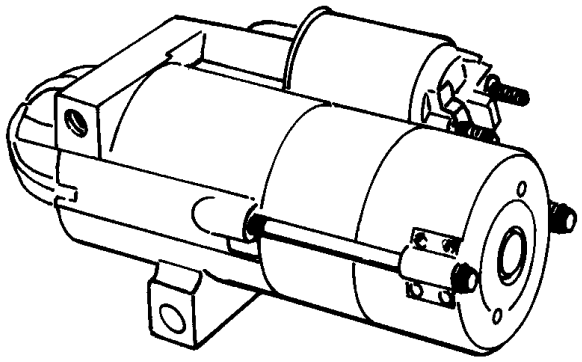
Description

The Delco PG260 starter motor features small permanent magnets mounted inside the field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings.

⚠ CAUTION

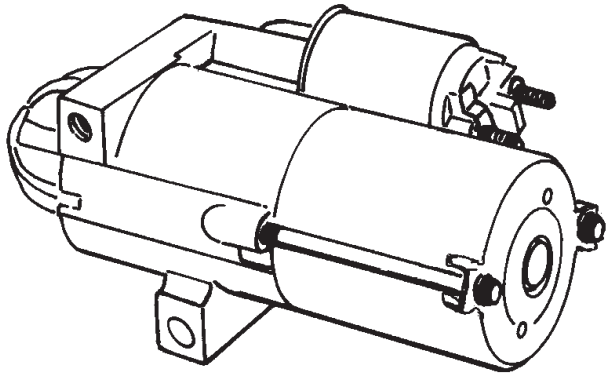
The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Identification



74041

Delco PG260 Starter Motor



75820

Delco PG260F1 Starter Motor

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

⚠ WARNING

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

NOTES:

Testing Starter Motors

NOTE: *See Information from Service Bulletin 2001-11 or appropriate service manual.*

No Trouble Found or Water in Starter Motors

Starter motors are returned for warranty that function properly when tested. The first test that should be done on an engine with a starter motor problem is to check the condition of the engine's cranking battery. If the fault is not with the battery, test the starter motor voltage as outlined in this bulletin.

There has also been either water or corrosion found inside starter motors returned for warranty. Condensation will not cause the amount of damage found. Inspect all starter motor failures for signs of water damage before sending it in for warranty.

Testing the Starter Motor with a Voltmeter

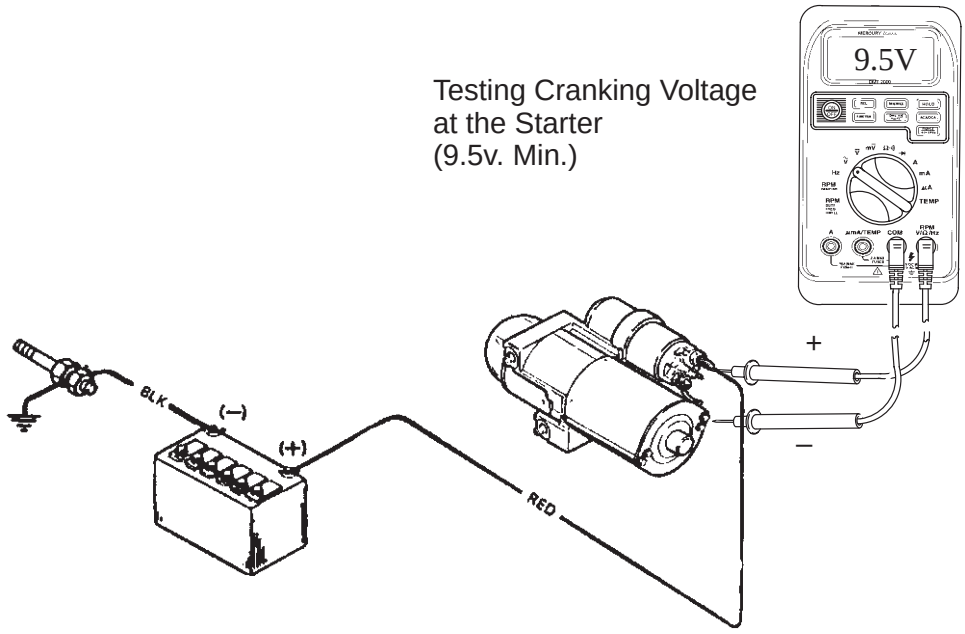
Other than water damage, low voltage is the number one cause of shortening the expected life of a starter motor. Low voltage causes excessive heat to build up in the starter motor. It can also cause starter motor solenoid contact problems. Perform these tests before removing starter from the engine.

1. An analog or digital voltmeter can be used, but the digital meter is best.

NOTE: *Be sure to '0' meter before making the test and that the boat's battery is fully charged.*

2. Remove the coil wire from distributor cap and ground it so engine does not start.
3. Connect voltmeter positive (+) lead directly to the large, threaded starter motor terminal that the battery positive (+) cable is connected to.
4. Connect voltmeter negative (–) lead directly to an unpainted metal surface on starter housing.
5. Crank engine over with key switch for about 10-15 seconds and watch the voltmeter.

6. A voltmeter reading of 9.5 volts or more indicates that there is sufficient voltage being supplied to the starter to operate properly.
   a. If the starter does not function like it should, there could be a problem with the starter or the engine. Remove the spark plugs and try turning the engine over by hand to rule out the engine itself.
7. A meter reading below 9.5v indicate voltage loss between the starter motor and the battery. Example: Voltage measured at the battery posts indicates 12.5v. You measure 9v at the starter. That means there is a 3.5v drop between the battery posts and the starter. Corroded battery cables, loose or dirty connections, loose battery cable terminal crimps, under size battery cable gauge for length used in boat, painted surfaces or battery switches could be the cause for this voltage drop.



Look for cause of low voltage by using the following test.

8. Test the battery positive (+) cable first. Connect voltmeter (+) lead directly to the battery (+) post, not the battery cable ring terminal. Connect voltmeter (–) lead directly to the large, threaded starter motor terminal that the battery (+) cable is connected to.

NOTE: *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

   a. Crank engine over while looking at the voltmeter.

The maximum allowed drop is 0.25v.

   b. To find the point where the resistance is highest, leave the voltmeter (+) lead on the battery post and move the voltmeter (–) lead to the battery (+) cable ring terminal, that is on the threaded starter terminal.
   c. Next, move voltmeter (–) lead to the battery cable itself that is inside the crimped battery cable ring terminal.
   d. Test each battery cable connection in this manner all the way back to the battery (+) post. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.

9. Check for voltage drop on battery negative (–) cable. Connect voltmeter (–) lead directly to the battery (–) post, not the battery cable ring terminal. Connect voltmeter (+) lead to an unpainted surface of the starter housing.

NOTE: *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

   a. Crank engine over while looking at the voltmeter.

The maximum allowed drop is 0.25v.

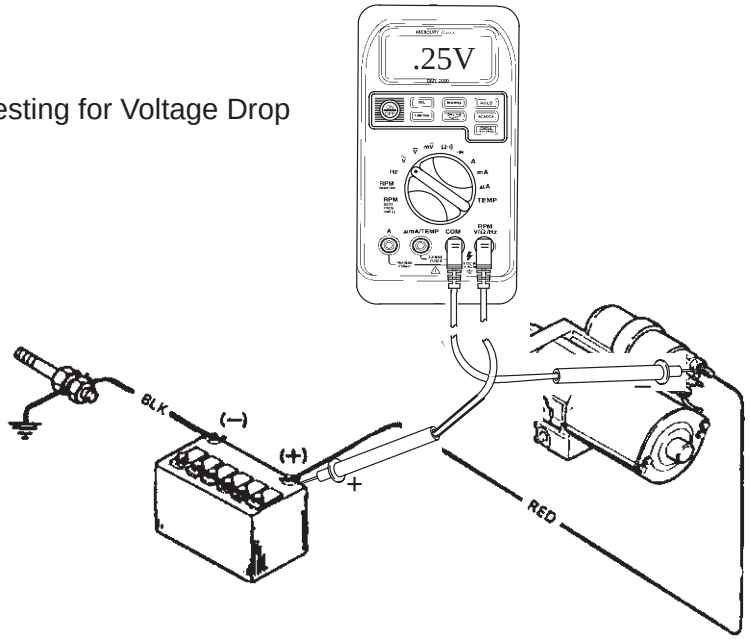
   b. To find the point where the resistance is highest, leave voltmeter (–) lead on battery (–) post and move voltmeter (+) lead to the ground stud where the battery (–) cable is connected.

   c. Then move the voltmeter (+) lead to the battery (–) cable ring terminal, that is on the ground stud.

   d. Next, move voltmeter (+) lead to the battery cable itself that is inside the crimped battery cable ring terminal.

   e. Test each battery cable connection in this manner all the way back to the battery post.

Testing for Voltage Drop



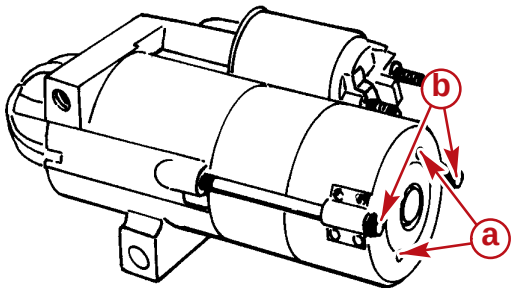
10. After testing to ensure that the starter motor is getting at least 9.5v, test the starter motor solenoid to see if it is getting at least 9.5v from the slave solenoid during cranking. Low voltage at the starter solenoid can cause intermittent operation of the solenoid contacts and shorten the life of it.

   a. Connect the voltmeter (+) lead to the terminal on the starter solenoid that has the YEL/RED wire from the slave solenoid connected to it. Connect the voltmeter (–) lead to unpainted surface of the starter housing.

   b. Crank engine over and watch the voltmeter. If the starter solenoid is not getting 9.5v, the YEL/RED wire or the slave solenoid could be the cause of the low voltage.

Water or Corrosion Inspection

1. Delco PG260 models only, remove the 2 short screws from the end cap and look at the threads.
   a. If they are clean and gold in color, the starter motor did not have water inside of it.
   b. If they are dirty and black or gray in color, the starter motor may have had water on the inside of it, go to step 2.
2. Remove the 2 long bolts to disassemble and inspect the inside of the starter motor.
   a. Heavy rust and corrosion inside the starter motor indicates water damage.
   b. If starter motor has little or no signs of rust or corrosion on the inside, go to step 3.
3. Remove starter solenoid. Look at condition of solenoid plunger grease.
   a. Brown or red rust colored grease or if the plunger is rusty, solenoid has been under water.
4. If no signs of rust or corrosion is found after steps 1-3, place all loose parts in a sealed plastic bag. Return starter motor and bagged parts with warranty claim.



74041

All Delco Starter Motors

a - Short Screws, PG260 Models Only
b - Long Screws

Replacing Starter Motors

When a starter motor is replaced, retest the voltage at the starter motor to ensure that it is getting a minimum of 9.5 volts.

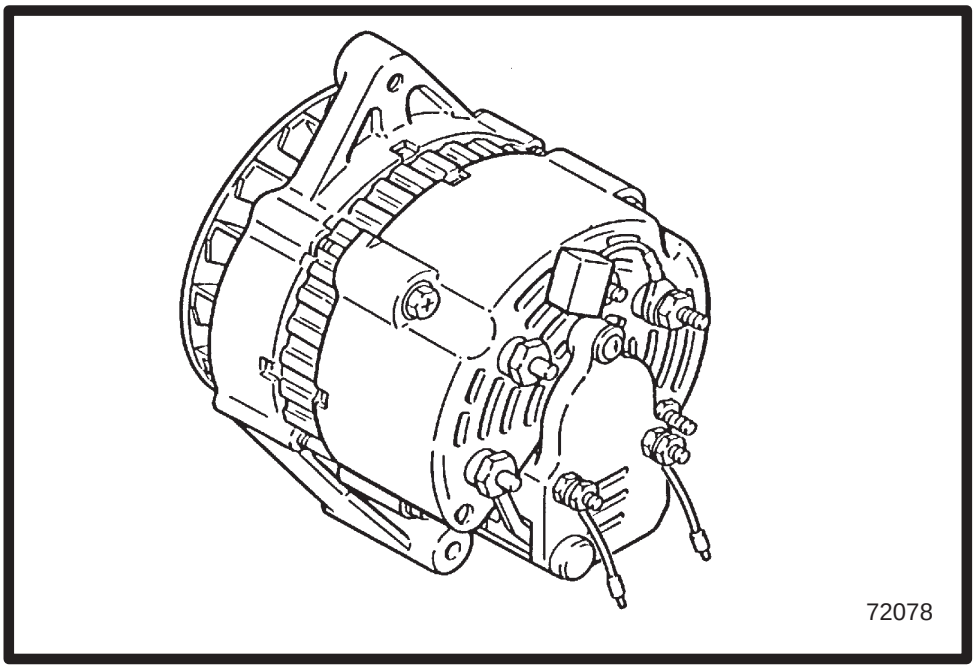
If a complete starter motor is needed for warranty replacement, it must be ordered from Mercury Parts. The use of any other company's starter motor as a warranty replacement is not allowed.

Warranty

Any starter motor returned for warranty that has either a "no trouble found condition" or signs of water being on the inside of it, will have the warranty claim rejected and the part returned to the dealer.

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2
C



CHARGING SYSTEM

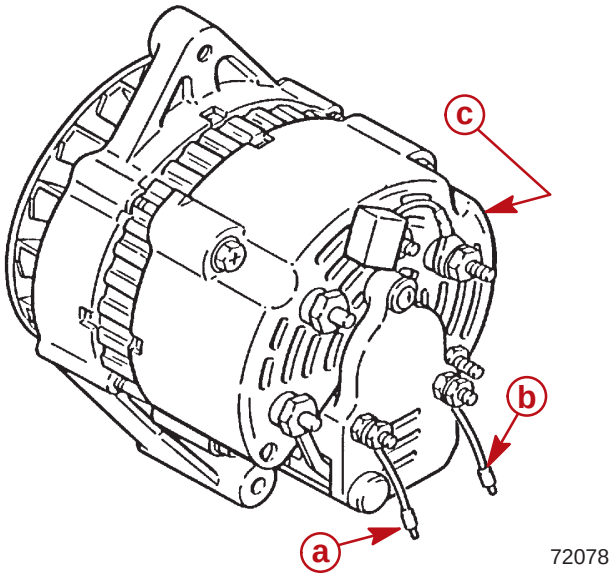
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Electrical Systems - Charging System

Identification

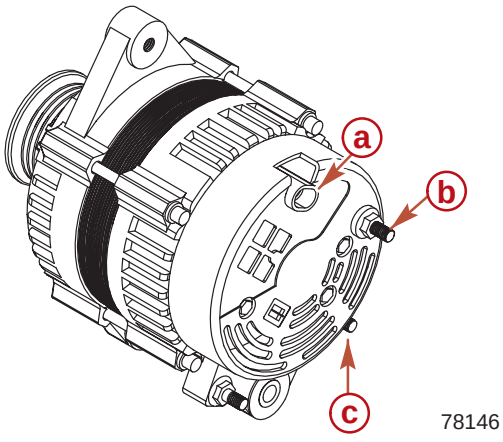
MANDO ALTERNATOR



Mando 55 Amp Alternator

- **a** - Excitation Wire - Purple
- **b** - Sensing Wire - Red/Purple
- **c** - Mando Part Number (Hidden in This View)

DELCO ALTERNATOR



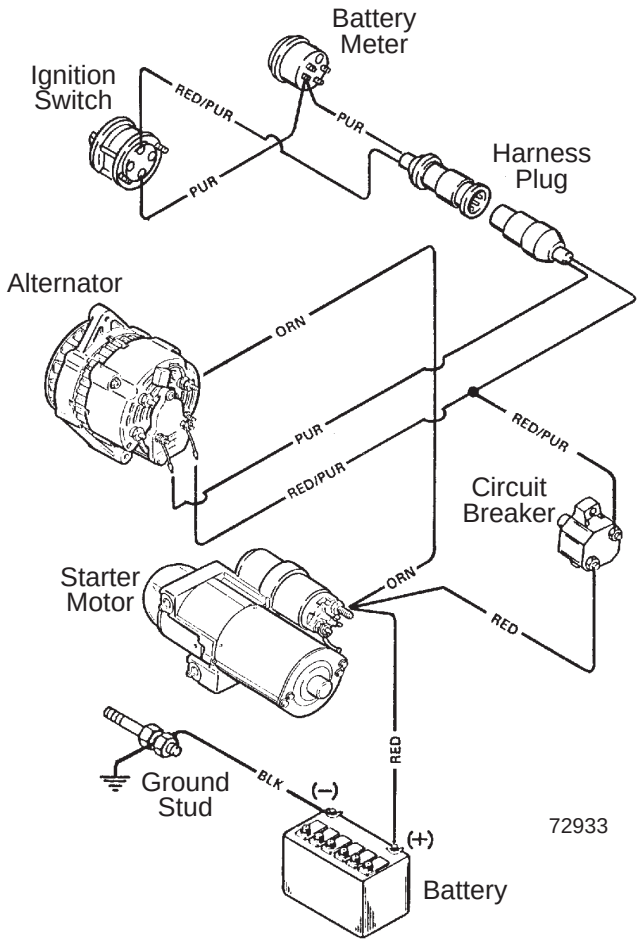
Delco Alternator

- **a** - RED and RED/PUR Connector
- **b** - ORN (Output) Terminal
- **c** - Ground

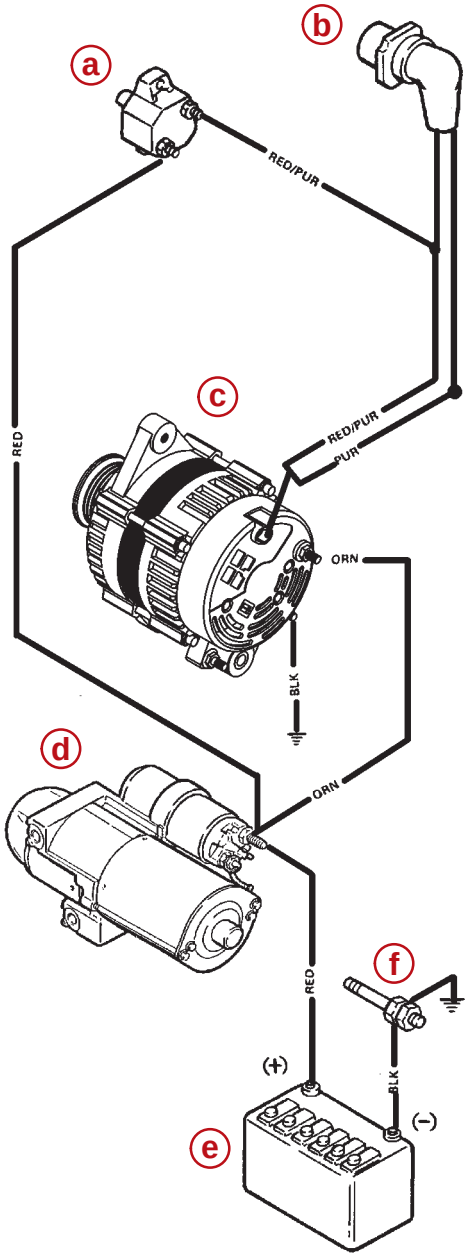
System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.

Mando

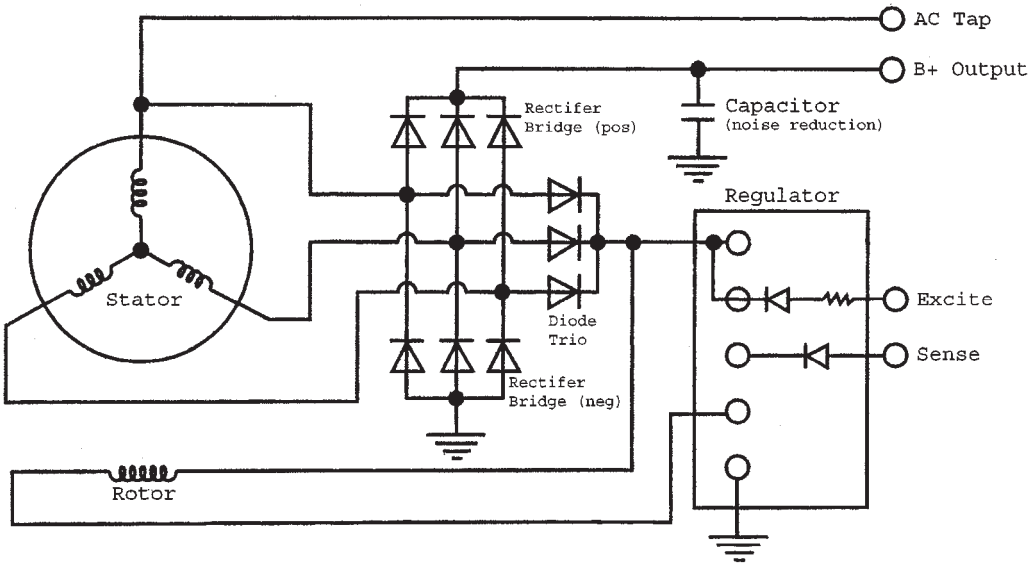


Delco

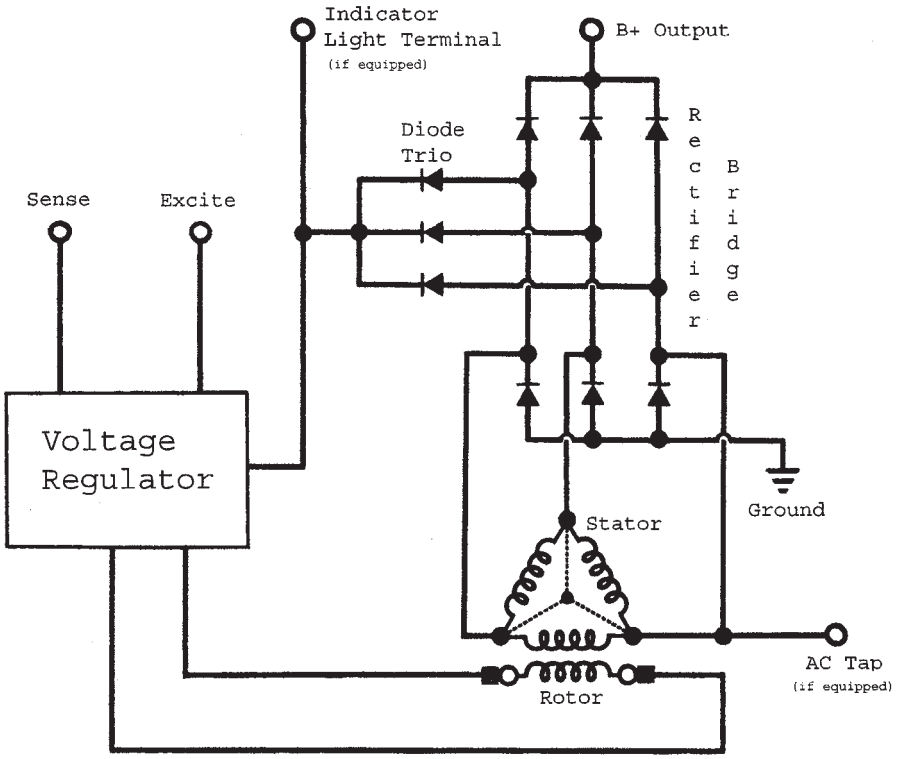


a - Circuit Breaker
b - Harness Connector
c - Alternator
d - Starter
e - Cranking Battery
f - Ground Stud

Alternator Block Diagram with Regulator Detail (Typical)



Alternator Block Diagram (Typical)



Testing Alternator Output with a Voltmeter

NOTE: *Information from Service Bulletin 2001-12 (August 2001).*

Models

All MerCruiser engines.

No Trouble Found

Alternators are returned for warranty that function properly when tested. The first test that should be done on an engine with a charging problem is to check the condition and tightness of the alternator drive belt. Next, check the condition of the cranking battery. If the fault is not with the belt or battery, test the alternator as outlined in this bulletin.

NOTE: *Each time an engine is started, the alternator has to reach about 1000 engine rpm before it will put out charging current.*

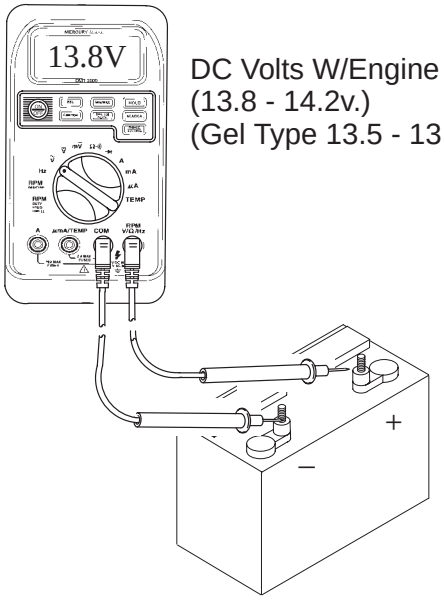
Testing the Charging System

Perform this test before removing the alternator from the engine.

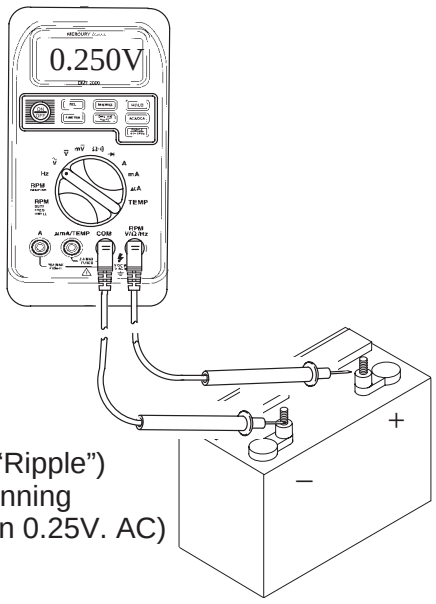
1. An analog or digital voltmeter can be used, but the digital meter is best.

NOTE: *Be sure to '0' meter before making the test and that the boat's battery is fully charged.*

2. Connect voltmeter positive (+) lead directly on the battery positive (+) post, not the battery cable ring terminal
3. Connect voltmeter negative (–) lead directly on the battery negative (–) post, not the battery cable ring terminal.
4. Start the engine, increase rpm to 1300, and observe voltmeter reading.
   a. Most systems will give a reading of 13.8 to 14.2 volts. Some gel cell batteries have a lower voltage setting of 13.5 to 13.8v.
5. If the voltmeter is within range, leave the engine running, and switch voltmeter to the AC volt position and observe voltmeter reading.
   a. A reading of 0.25 AC volt or less while charging indicates the diodes are good.
   b. A reading of more than 0.25 AC volt indicates that the alternator has defective diodes.



DC Volts W/Engine Running
(13.8 - 14.2v.)
(Gel Type 13.5 - 13.8v.)



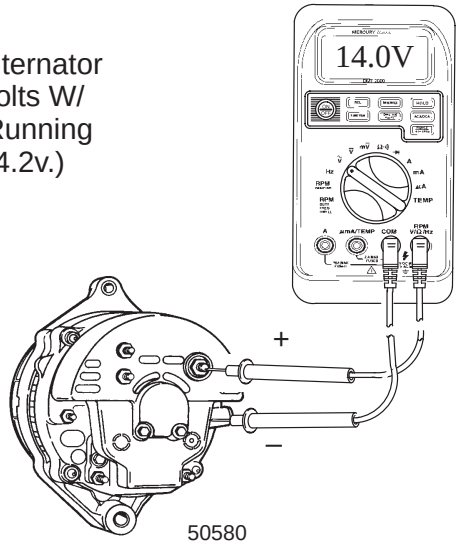
AC Volts (or "Ripple")
W/Engine Running
(No more than 0.25V. AC)

6. If voltmeter reading stays above 15v all the time, the alternator is over charging the battery and alternator needs to be repaired.
7. If the voltmeter reading is below 13.5v, the alternator is not charging properly.
   a. Check for battery voltage at the RED/PUR wire at the alternator.
   b. Check for battery voltage at the PUR wire at the alternator with the key switch 'ON'.

NOTE: *Make sure engine wiring harness leads and the alternator leads are not reversed.*

   c. If both wires have battery voltage, go to step 8.
8. If voltmeter reading is below 13.5v, connect voltmeter (+) lead to output terminal on the alternator and the voltmeter (–) lead to the ground terminal on the alternator.
9. Repeat step 4. If reading now is within range, resistance in the charging circuit is the problem.

Check Alternator for DC Volts W/ Engine Running (13.8 - 14.2v.)

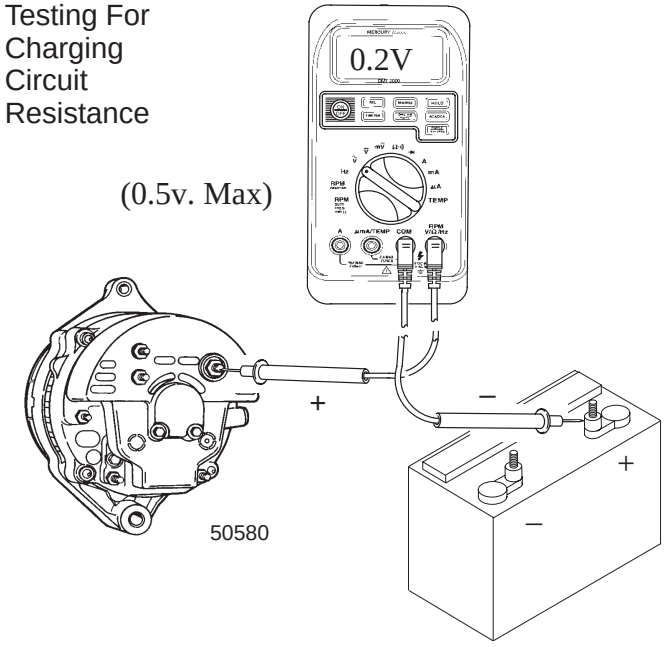


10. Test for resistance on the alternator output circuit first. Loose or corroded connections in the alternator output circuit can cause charging system problems.
    a. Discharge the battery by grounding the ignition coil high tension wire and crank the engines over for 10-15 seconds.
    b. Turn off all accessories.
    c. Connect voltmeter (+) lead directly to the alternator output terminal, not the ORN wire ring terminal. Connect voltmeter (–) lead directly to the battery (+) post.
    d. Start engine, increase rpm to 1300, and observe voltmeter reading.

The maximum allowed is 0.5v.

    e. To find the point where the resistance is highest, leave the voltmeter (–) lead on the battery post and move the voltmeter (+) lead to the alternator ORN wire ring terminal.
    f. Next, move voltmeter (+) lead to the ORN wire itself that is inside the crimped ring terminal.

g. Test each alternator output wire connection in this manner all the way back to the battery (+) post. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.



11. Test for resistance on the alternator ground next.

a. Repeat 'a' and 'b' in step 10.

b. Connect voltmeter (–) lead to ground terminal on the alternator, not the BLK wire ring terminal. Connect voltmeter (+) lead directly to the battery (–) post.

NOTE: *If alternator does not have a BLK wire connected to it, it is grounded internally. Connect voltmeter (–) lead to unpainted surface of the alternator.*

c. Start engine, increase rpm to 1300, and observe voltmeter reading.

The maximum allowed is 0.5v.

d. To find the point where the resistance is highest, leave the voltmeter (+) lead on the battery post and move the voltmeter (–) lead to the alternator BLK wire ring terminal.

NOTE: *If alternator does not have a BLK wire connected to it, go to 'f'.*

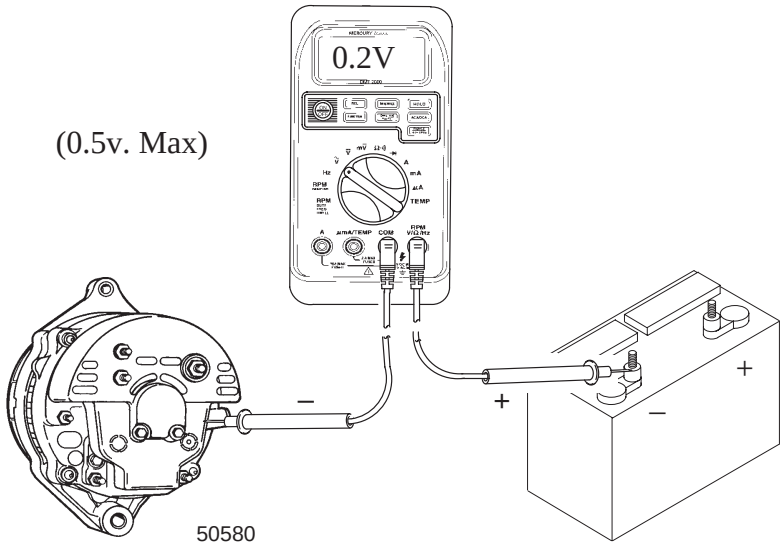
e. Then move voltmeter (–) lead to the BLK wire itself that is inside the crimped ring terminal.

f. Next, move voltmeter (–) lead to the ground stud where the battery (–) cable is connected.

g. Move the voltmeter (–) lead to the battery (–) cable ring terminal, that is on the ground stud.

h. Move voltmeter (–) lead to the battery cable itself that is inside the crimped battery cable ring terminal.

i. Test each battery cable connection in this manner all the way back to the battery post.



Replacing Alternators

When an alternator is replaced, retest the voltage at the battery posts to ensure that the alternator is charging the battery.

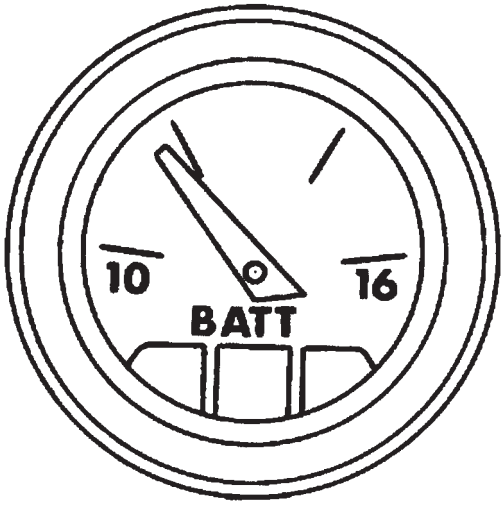
If a complete alternator is needed for warranty replacement, it must be ordered from Mercury Parts. The use of any other company's alternator as a warranty replacement is not allowed.

Warranty

Any alternator returned for warranty that has a "no trouble found condition", will have the warranty claim rejected and the part returned to the dealer.

Alternator Charging Voltage RPM

Alternators will not put out 13.5 volts until they reach 800 rpm. After that they will put out charging voltage at any rpm. Half of the alternators returned for warranty operate correctly. 25% of the returned units have water in them. 25% of the returned units have actually failed.



72751

Charging System Testing and Repair

Consult appropriate service manual for testing and repair information. Also see Service Bulletin 2001-12.

MANDO ALTERNATOR – SERVICE MANUAL #24*.

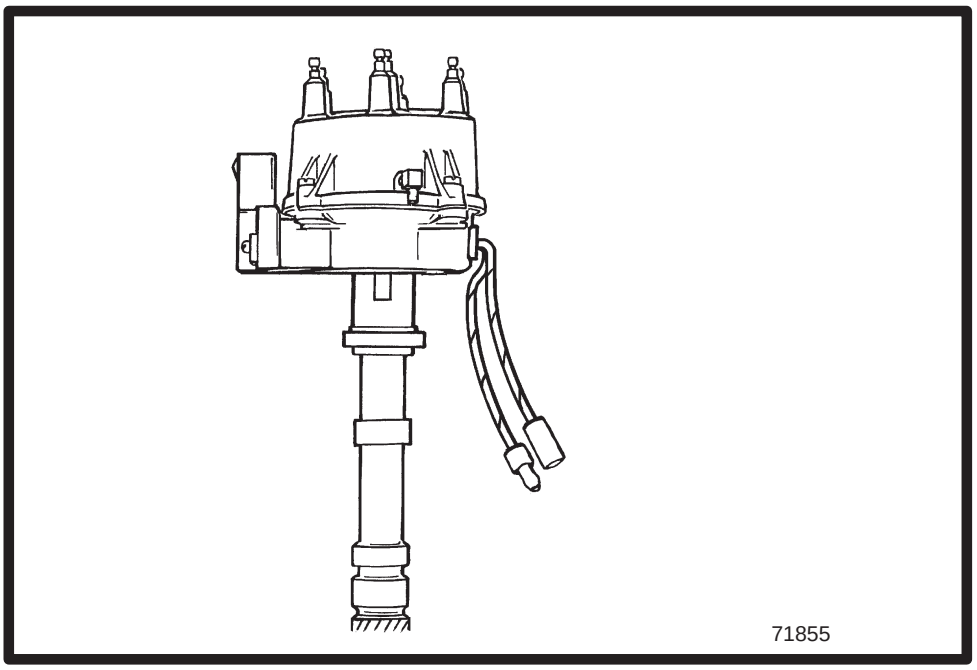
DELCO ALTERNATOR – SERVICE MANUAL #31*.

*Several service manuals have alternator testing and repair information. These particular manuals are given only as examples.

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2

D

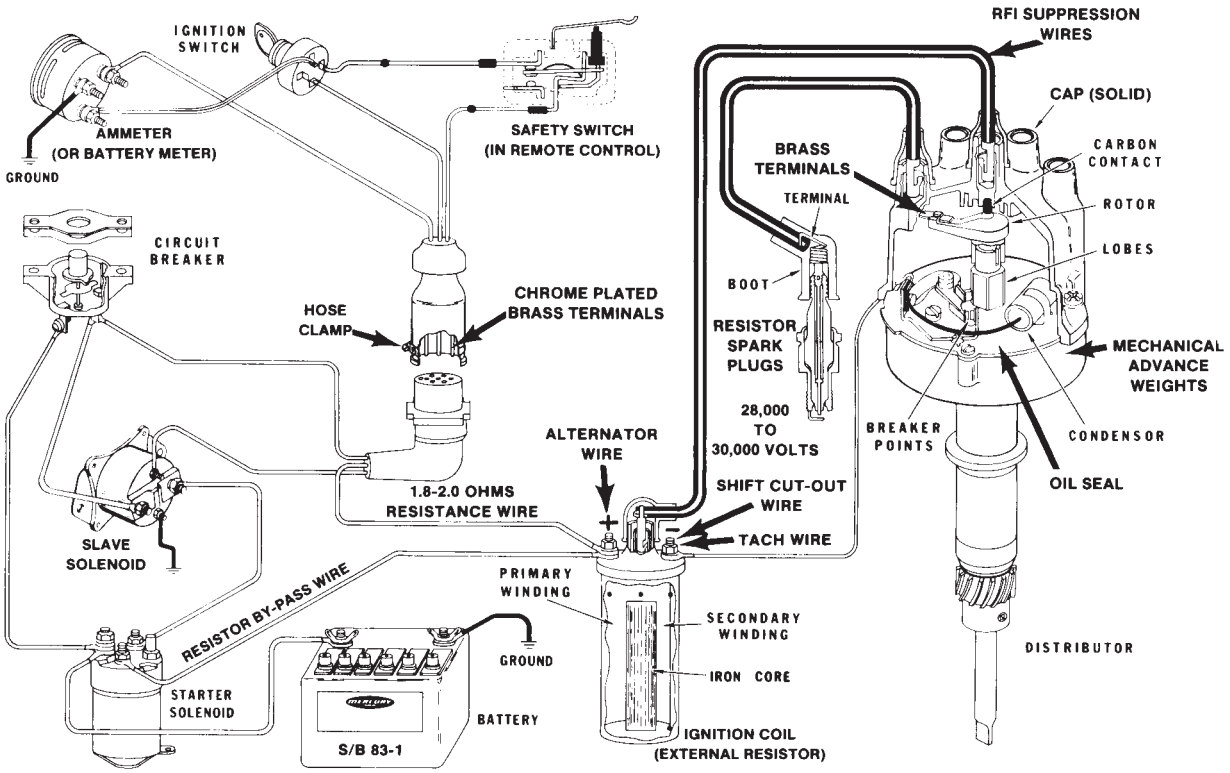


IGNITION SYSTEMS

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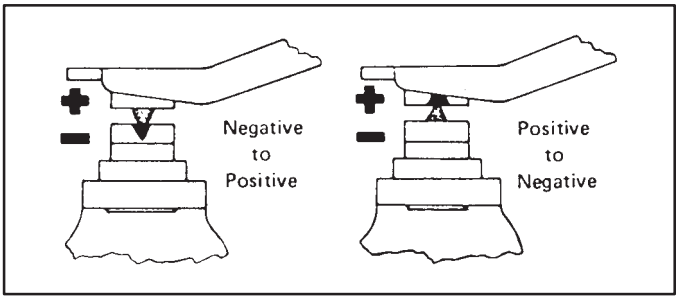
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Conventional Ignition System (Delco-Remy and Prestolite)

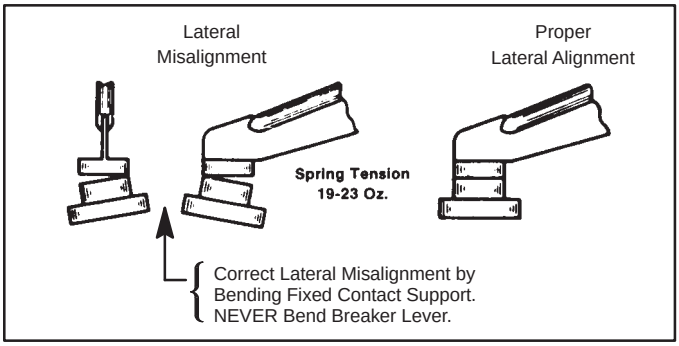


Replacement Ignition Resistance Wire (All Models) Parts Bulletin 93-5

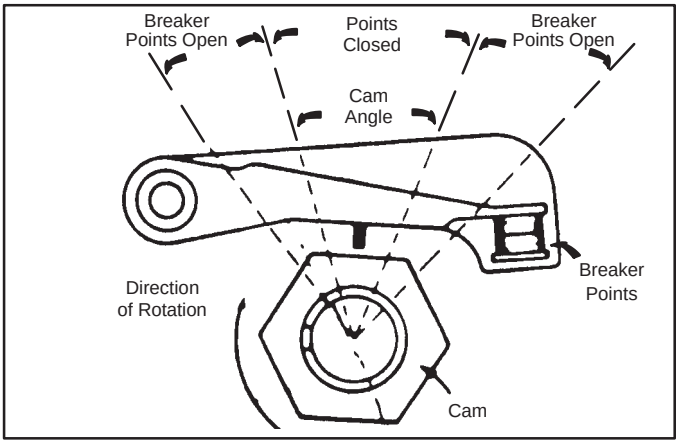
Ignition Contact Points



Contact Point Material Transfer


Lateral Misalignment
Proper Lateral Alignment
Spring Tension 19-23 Oz.
Correct Lateral Misalignment by Bending Fixed Contact Support. NEVER Bend Breaker Lever.

Point Alignment

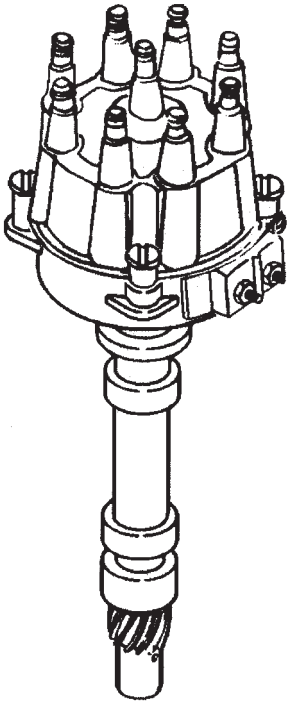


Cam Angle

NOTES:

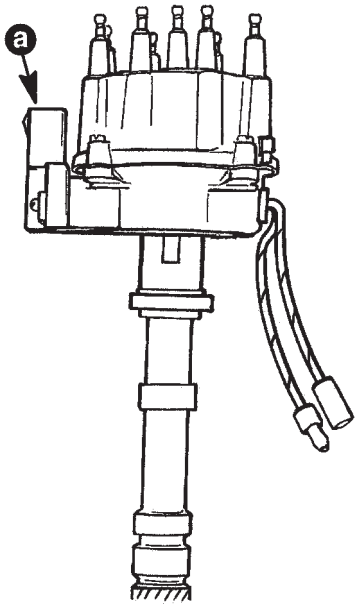
Thunderbolt IV Ignition System

Thunderbolt IV Distributor - Identification



71790

Distributor with Ignition Module Mounted on Exhaust Elbow



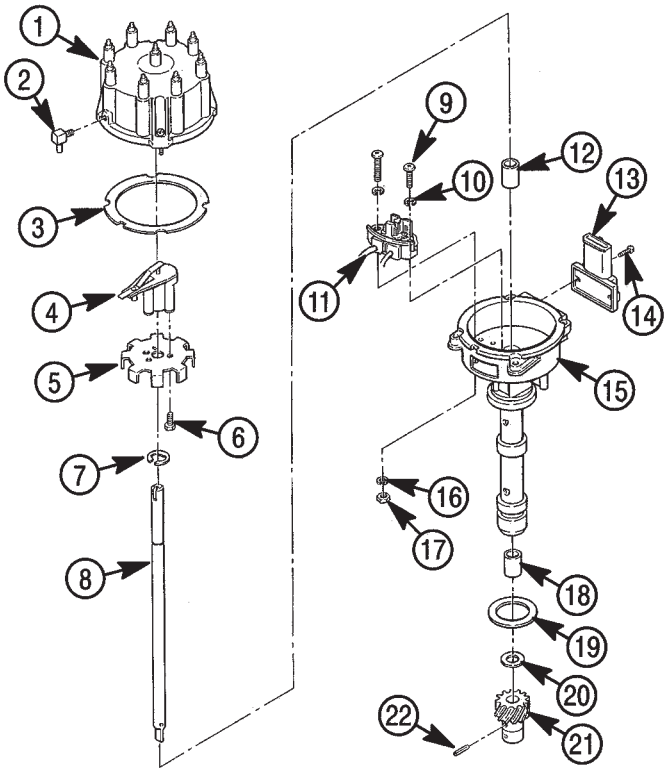
72722

a - Ignition Module

Distributor with Ignition Module Mounted on Distributor Body

NOTE: *Repair procedures for both distributors, except for ignition module replacement, are the same.*

Exploded View (Typical)

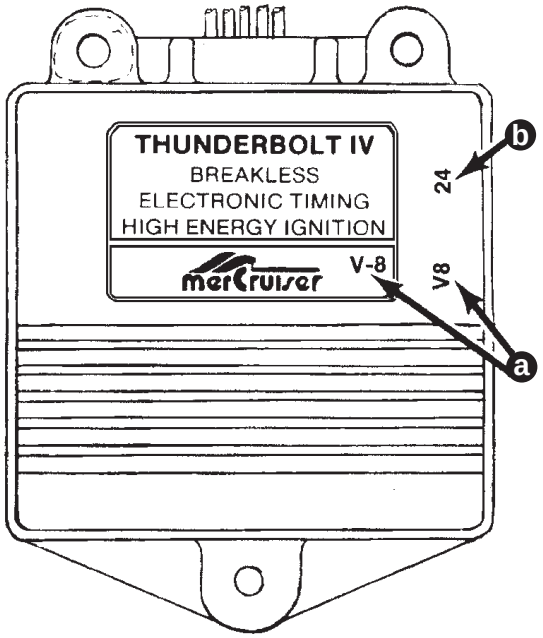


72058

1 - Distributor Cap
2 - Vent
3 - Gasket
4 - Rotor
5 - Sensor Wheel
6 - Screws (3)
7 - E-Clip
8 - Shaft
9 - Screws (2)
10 - Lockwashers (2)
11 - Sensor
12 - Upper Bushing
13 - Ignition Module [If So Equipped (Apply Thermalconductive Grease)]
14 - Screws (2)
15 - Distributor Housing
16 - Lockwasher
17 - Nut
18 - Lower Bushing
19 - Gasket
20 - Washer
21 - Gear
22 - Roll Pin

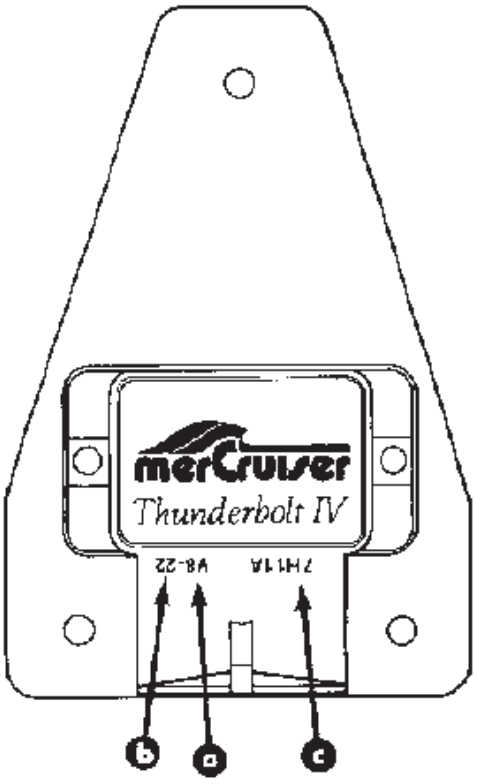
Thunderbolt IV Module Identification

Exhaust Elbow Mounted Module



a - Engine Type
b - Spark Advance Degrees

Aluminum Module (1)

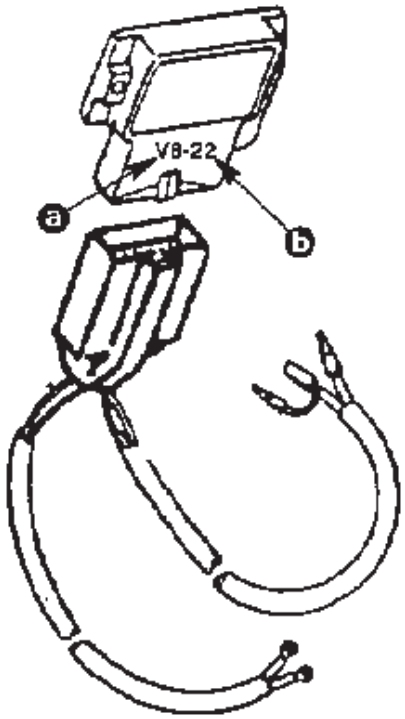


1372-H

a - Engine Type
b - Spark Advance Degrees
c - Vendor Code

Plastic Module (2)

Distributor Mounted Module



a - Engine Type
b - Spark Advance Degrees

Distributor Mounted Module (3)

Old Aluminum Module (1)	New Plastic Module (2)	Distributor Mounted (3)	Engine Type Degrees of Advance
390-9355A2	15247A1	805361T-1	V6-14
390-9607A3	15899A1	805361T-3	V8-22
	814295A1	805361T-4	V8-22A
	821125A1	805361T-6	V8-24S
390-7804A3	15248A1	805361T-2	V8-24
	817509T	805361T-5	V8-20R
390-9571A1	17316A1		V8-HP

Ignition System Advance Specifications S/B 91-12

Incorrect Module 502 Magnum S/B 90-16

V8-V6 High Speed Miss S/B 89-27

Using Timing Advance Lights S/B 86-4

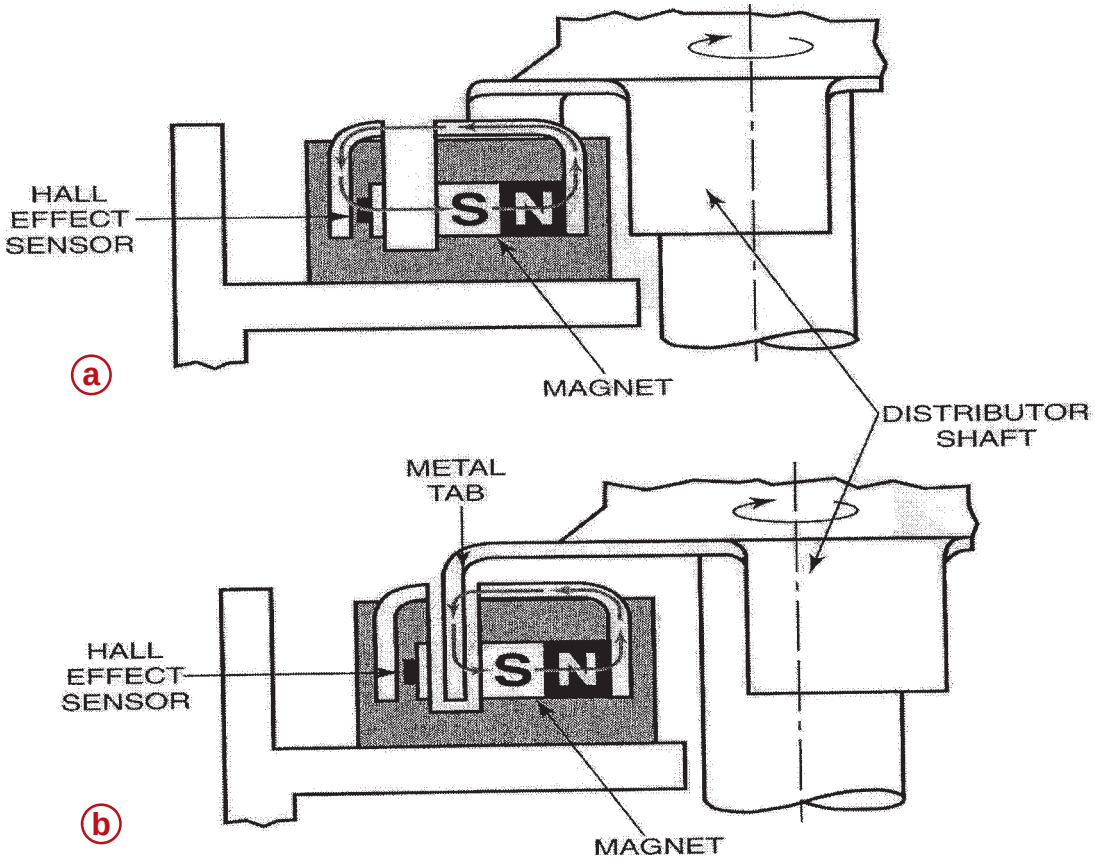
Amplifier Advance Curve Change S/B 87-17

Shaft Roll Pin Hole Oversize S/B 89-7

Hall-Effect Sensor

The **Hall-effect sensor** is mounted in the distributor. The Hall-effect sensor (or switch) is a thin wafer of semiconductor material which constantly has voltage applied to it. A magnet is located opposite the sensor, with an air gap between the sensor and the magnet.

The magnetic field acts on the sensor until a metal tab (sensor wheel) is placed between the sensor and magnet. This metal tab does not touch the magnet or the sensor. When contact between the magnetic field and sensor is interrupted, it causes its output voltage to be reduced. This signals the ignition module to turn the power transistor off which interrupts primary current to the ignition coil -- causing it to fire.



a - A magnetic field can act on a Hall-effect sensor

b - When the metal tab, attached to the distributor shaft rotates between the magnet and Hall-effect sensor, the magnetic field is interrupted. The ignition coil sends high voltage to the distributor any time the magnetic field is interrupted. (Robert Bosch)

Testing Thunderbolt IV HEI System

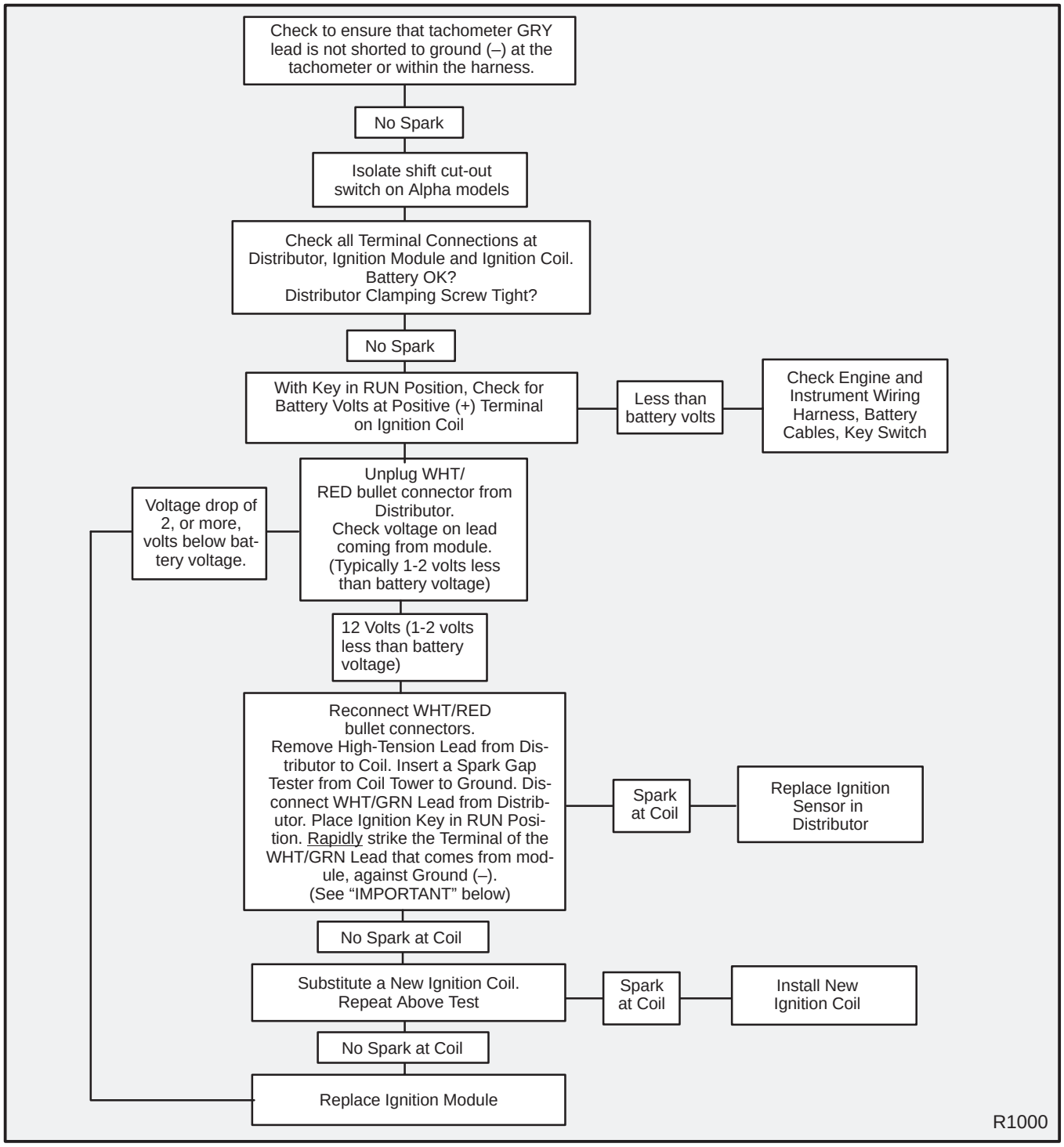
TROUBLESHOOTING THUNDERBOLT IV IGNITION SYSTEM

The ignition system consists of four components and a 12-volt source to operate it. The four components are: ignition coil, ignition module, ignition sensor and sensor wheel.

To troubleshoot the ignition system all that is needed is a voltmeter and Spark Gap Tester (C-91-63998A1).

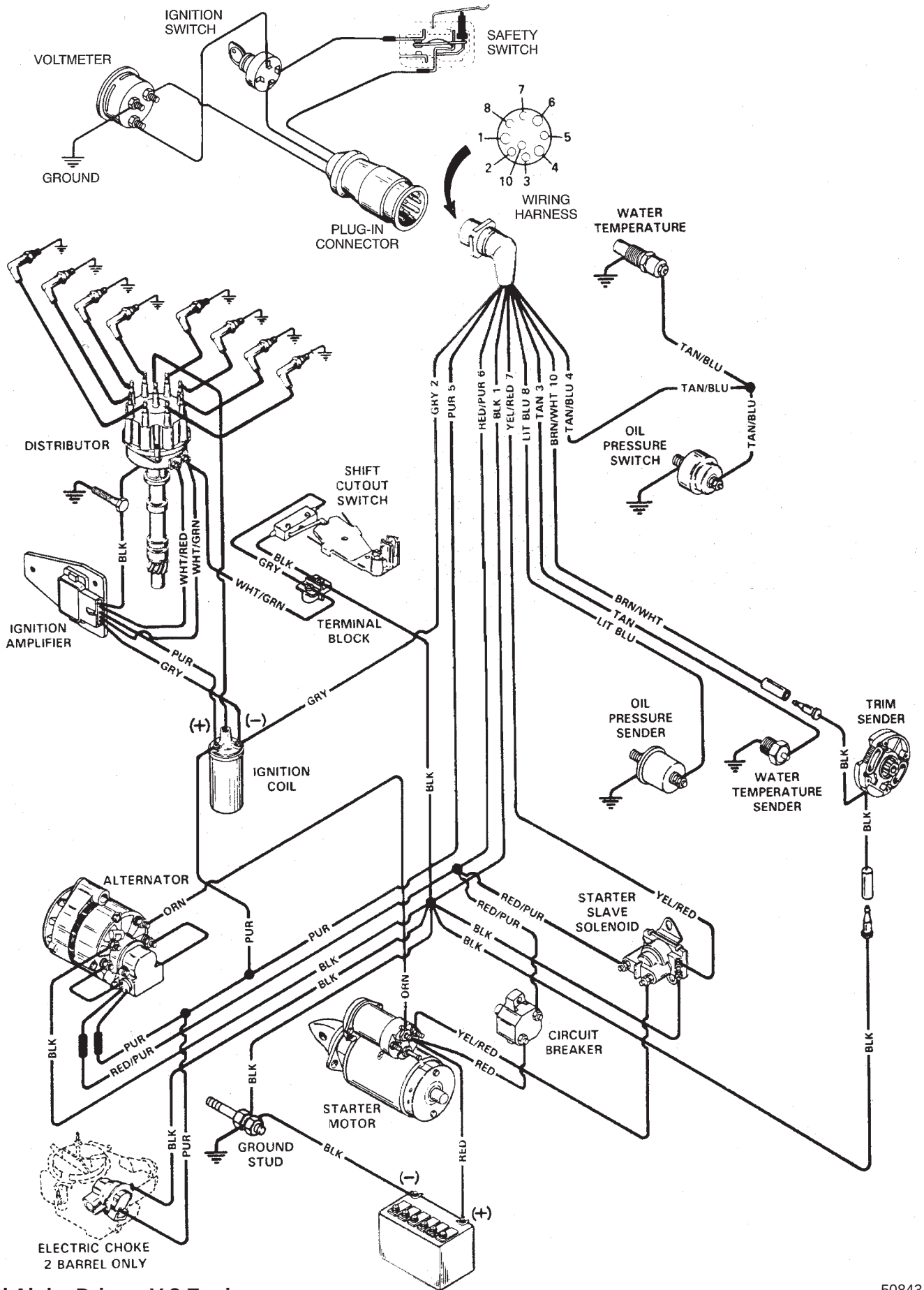
⚠ WARNING

Before testing ignition system, operate bilge blower for at least 5 minutes to remove any explosive fumes from engine compartment. If boat is not equipped with a bilge blower, open engine hatch.


Check to ensure that tachometer GRY lead is not shorted to ground (–) at the tachometer or within the harness.
No Spark
Isolate shift cut-out switch on Alpha models
Check all Terminal Connections at Distributor, Ignition Module and Ignition Coil. Battery OK? Distributor Clamping Screw Tight?
No Spark
With Key in RUN Position, Check for Battery Volts at Positive (+) Terminal on Ignition Coil
Less than battery volts
Check Engine and Instrument Wiring Harness, Battery Cables, Key Switch
Unplug WHT/RED bullet connector from Distributor. Check voltage on lead coming from module. (Typically 1-2 volts less than battery voltage)
Voltage drop of 2, or more, volts below battery voltage.
12 Volts (1-2 volts less than battery voltage)
Reconnect WHT/RED bullet connectors. Remove High-Tension Lead from Distributor to Coil. Insert a Spark Gap Tester from Coil Tower to Ground. Disconnect WHT/GRN Lead from Distributor. Place Ignition Key in RUN Position. Rapidly strike the Terminal of the WHT/GRN Lead that comes from module, against Ground (–). (See "IMPORTANT" below)
Spark at Coil
Replace Ignition Sensor in Distributor
No Spark at Coil
Substitute a New Ignition Coil. Repeat Above Test
Spark at Coil
Install New Ignition Coil
No Spark at Coil
Replace Ignition Module
R1000

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Thunderbolt IV Ignition System Wiring Diagram



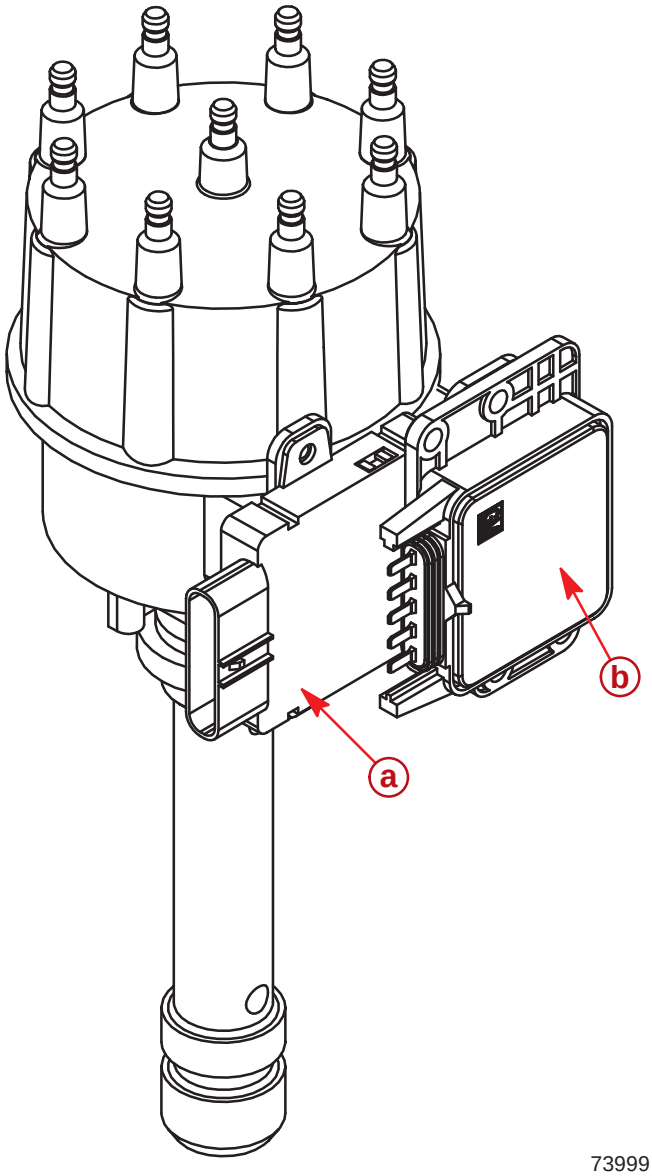
Typical Alpha Drive – V-8 Engines

50843

NOTES:

Thunderbolt V Ignition

The Thunderbolt V ignition system uses the same distributor as the Thunderbolt IV system. The system has a new Ignition Control Module with Digital Electronic Spark Advance (D.E.S.A.). There is also a Knock Control Module that is mounted with the ignition control module.



73999

a - Ignition Control Module
b - Knock Control Module

NOTE: *Earlier models have the modules mounted on the distributor. Later models have the modules mounted on the exhaust elbow.*

General Description

The Thunderbolt V ignition system has several spark control features that will be described following:

- Idle Speed Spark Control
- Acceleration Spark Advance
- Mean-Best-Timing Spark Advance
- Over-Speed Control (Rev-Limiter)
- Knock Retard Spark Control

Idle Speed Spark Control

The ignition module will control ignition timing to maintain a calibrated idle speed. This is accomplished by making small spark advance adjustments. This feature is only active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate range is 400-700 RPM.

Acceleration Spark Advance

This feature is active during acceleration only. When accelerating, the ignition module may add more spark advance to the “Base Spark Timing Curve”. The amount of spark advance added, is totally dependant on how fast RPM increases (how fast the throttle is moved). This feature is also active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

Mean-Best-Timing (MBT) Spark Advance

During light load cruising, the ignition module searches for the optimal ignition timing. This is also accomplished by small changes to the spark advance. At a given RPM, the module will try to add a small amount of advance and wait to see if there is an RPM change. If RPM increases, it will try to increase timing more. The module will continue to advance timing until it no longer gets an increase in RPM. Conversely, if it senses an RPM drop, it will start to retard some of the spark timing. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the ignition module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: *The Audio Warning System is also connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.*

Over-Speed Control

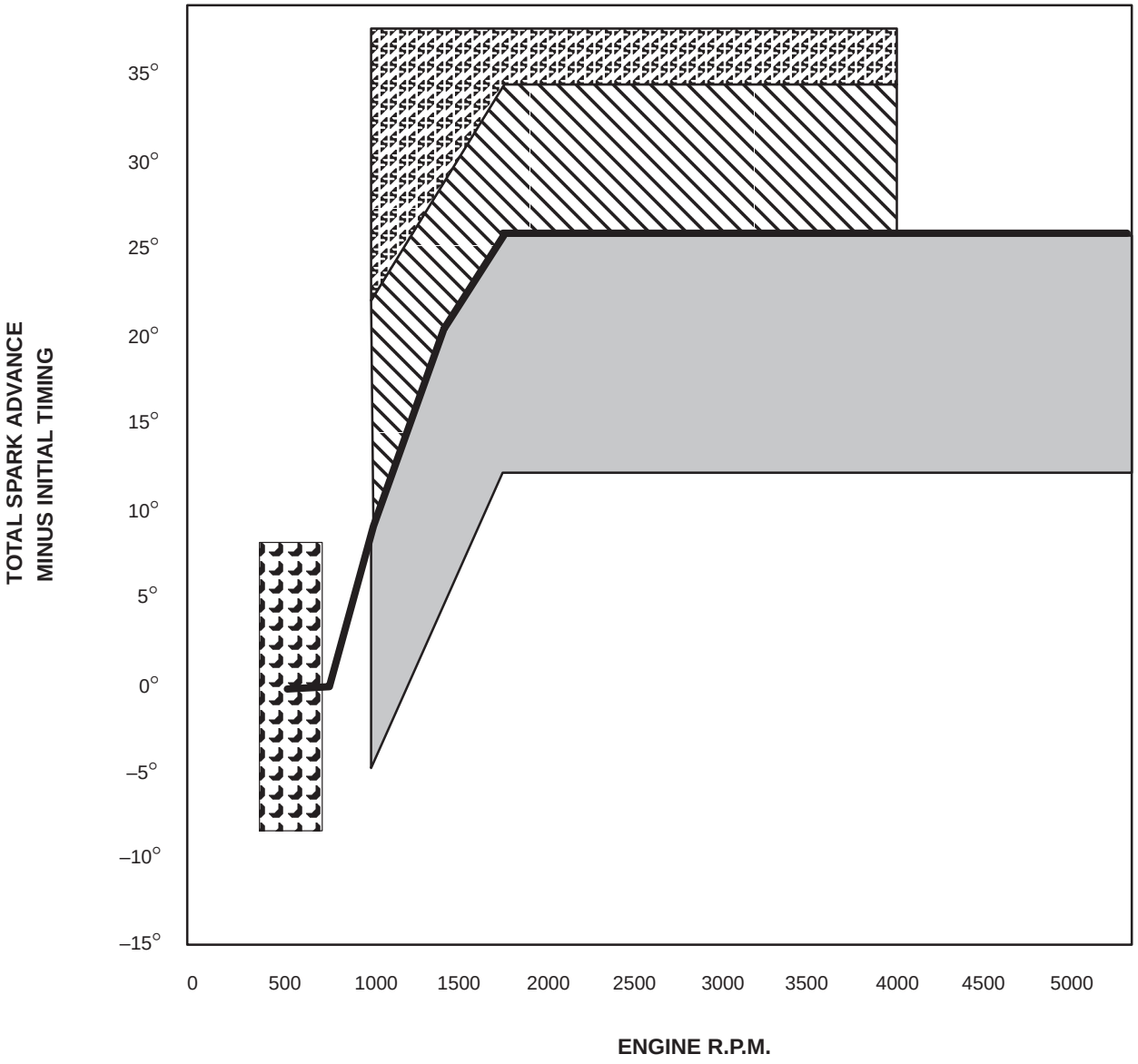
The ignition module will prevent the engine speed from exceeding a preset limit by stopping the spark. This feature has an RPM range that varies from model to model. The over-speed limit for a particular engine is set slightly higher than the top end of the RPM range for that model. For example, if the recommended range is 4600-5000 RPM, the over-speed limit would be set at 5100RPM. When RPM reaches this limit, spark is turned-off until engine RPM drops down to a “Reset RPM”, which would be approximately 4750 RPM for this example. At this point, spark comes back on.

Knock Retard Spark Control

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the Knock Control Module. This module receives a signal from a sensor that is mounted on the engine block. The knock control module works in conjunction with the ignition module to retard the timing if spark knock is present.

Thunderbolt V Spark Control Graph

IMPORTANT: The graph below shows the typical advance envelopes for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



= Base Timing Advance Curve

= Idle Speed Advance Envelope

= Knock Retard Envelope (If knock module is on engine)

= Acceleration Advance Envelope

= MBT Advance Envelope (Not on Tournament Ski engines)

NOTES:

Ignition Systems - Thunderbolt V Circuit Description

Refer to the circuit wiring diagram on the following page for reference to this circuit description.

Ignition Control Module

- The ignition module receives its power (+) thru the PURPLE wire “9”.
- Ignition module ground (–) is accomplished thru the BLACK wire “10”.
- There is also a Case Ground (–) wire “12” that is connected to one of the ignition module attaching screws. Later versions are grounded through the module mounting tabs.
- The 12 volt signal from the ignition module to the distributor is carried thru the WHITE/RED wire “8”, to the distributor sensor and back to the ignition module thru the WHITE/GREEN wire “7”.
- The tachometer signal is carried to the instrument panel thru the GRAY wire “11”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- There are two BLACK wires “5” that have bullet connectors. This circuit is reserved for future options. On current models, the two BLACK wires must be connected for the system to function properly.
- The TAN/BLU wire “6” carries a signal from the Audio Warning circuit to the ignition module.

Knock Control Module

- The knock control module receives it’s power (+) from the PURPLE wire “4”.
- Knock module ground (–) is accomplished thru the BLACK wire “2”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- The BLUE wire “1” carries the signal from the knock sensor to the knock module.

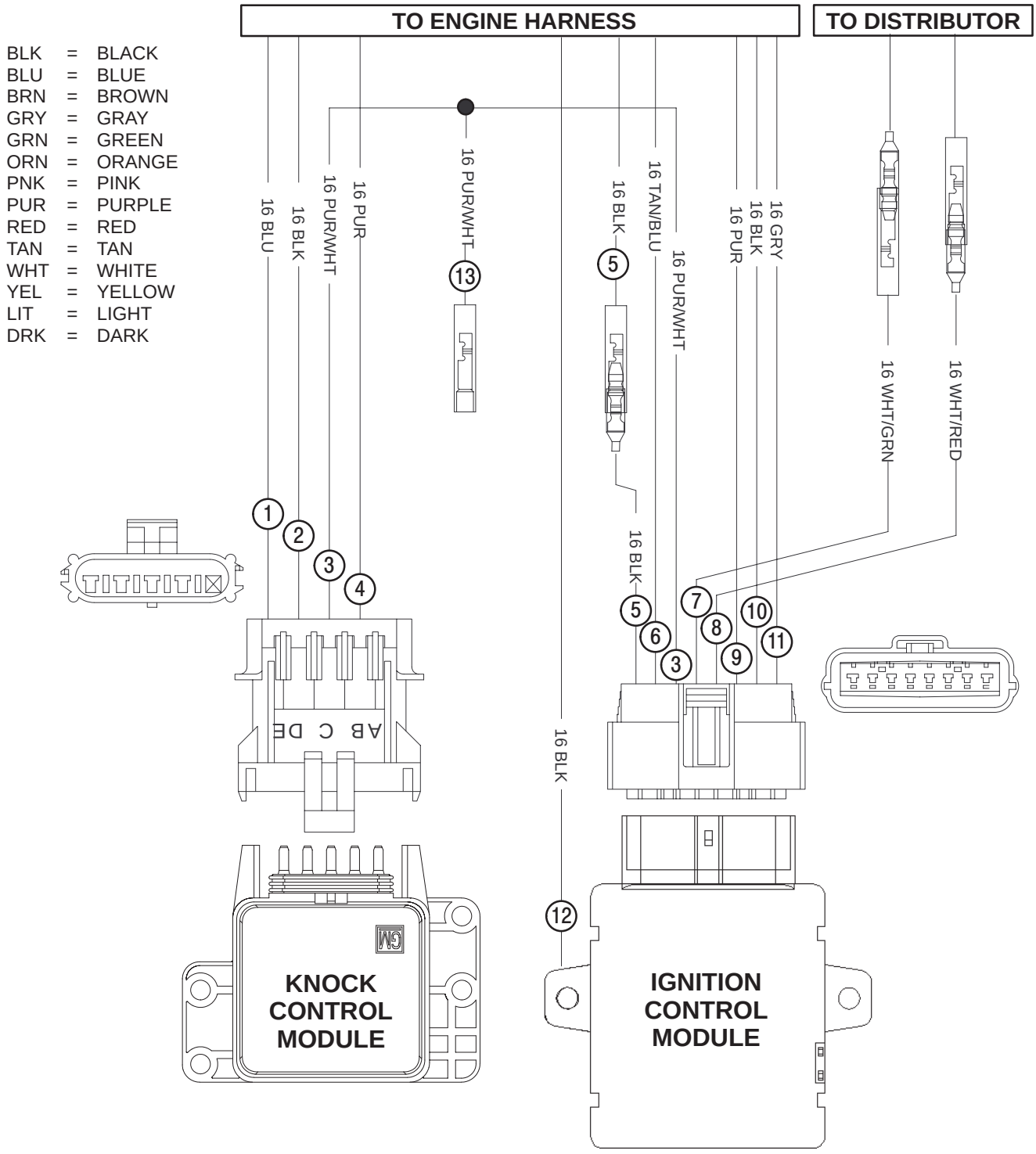
Ignition Control System Timing Lead

The ignition control system has a lead with bullet connector “13” that is connected into the PURPLE/WHITE wire “3”. This lead is used for performing the following tests and procedures:

- Setting “Base Ignition Timing”
- Setting “Engine Idle Speed”
- Setting “Idle Mixture”
- Testing Knock Control Circuit

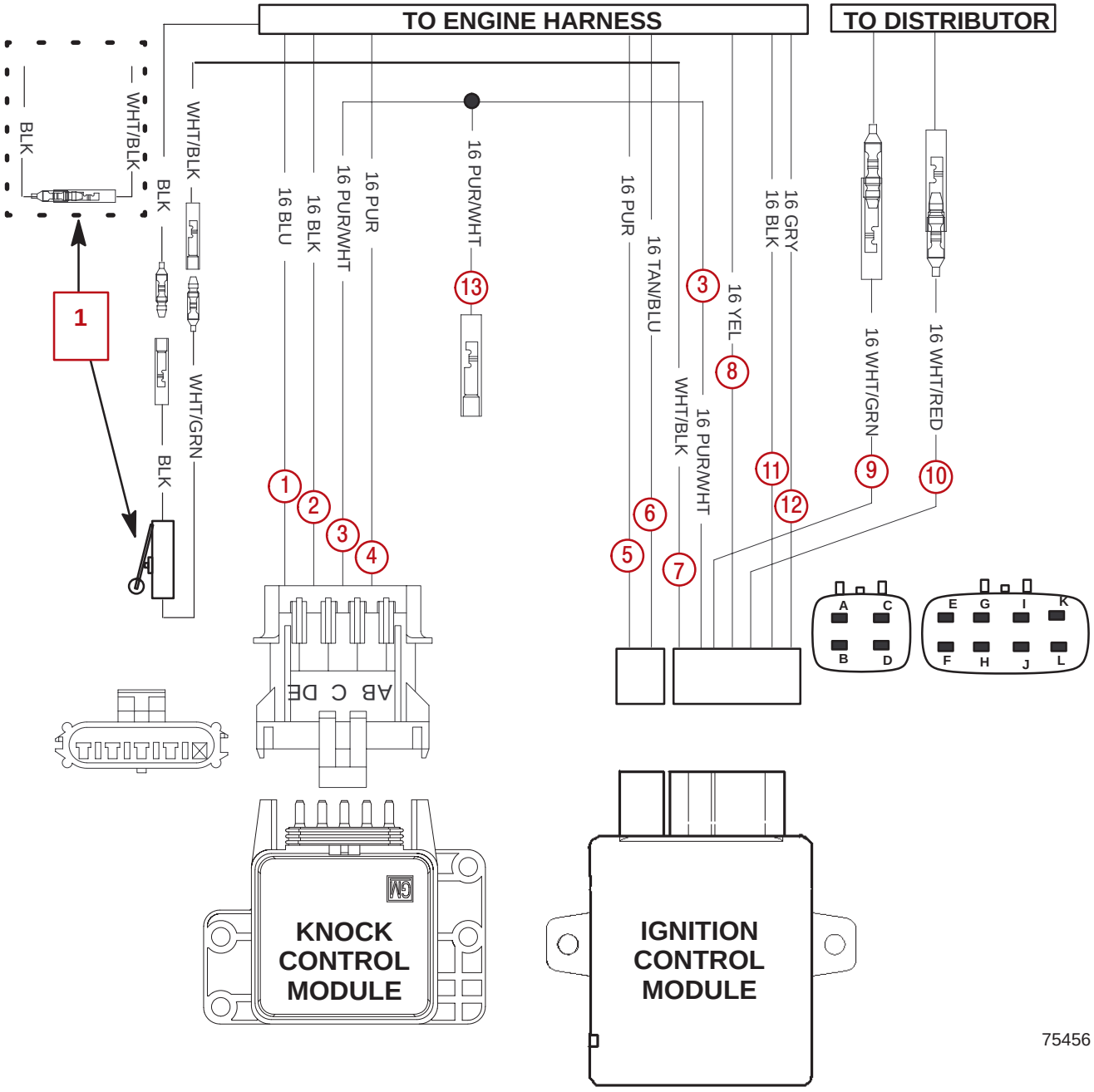
This lead, when connected to an engine ground (–), locks the ignition control module into the “Base Timing” mode.

Thunderbolt V Ignition System Wiring Diagram – 1997 and Older Models with Distributor Mounted Module (Bravo shown)



1 - Knock Sensor Wire
2 - Ground Wire (–) For Knock Module
3 - Knock Module Signal Wire
4 - Battery (+) Positive Wire To Knock Module
5 - Ground (–) For Future Options
6 - Audio Warning System Wire
7 - Distributor Wire
8 - Distributor Wire
9 - Battery (+) Positive Wire To Ignition Module
10 - Ground Wire for Ignition Module
11 - Tachometer Wire
12 - Ignition control (trigger) wire (Pin L)
13 - Timing Lead (for setting timing and other tests)

Thunderbolt V – 1998 and Newer Models with Exhaust Elbow Mounted Module (Alpha and Bravo Models - see Note 1) Ignition System Wiring Diagram



NOTE: *[1] Alpha Models Are Equipped With A Shift Cut-Out Switch. 305 and 350 cid Bravo Models Will Have Two BLACK Leads Connected Together.*

1 - Knock Sensor Wire
2 - Ground Wire (–) For Knock Module
3 - Knock Module Signal Wire
4 - Battery (+) Positive Wire To Knock Module
5 - Battery (+) Positive Wire To Ignition Module (Pin C)
6 - Audio Warning System Wire (Pin D)
7 - Shift System Interrupt Switch (If Equipped) (Pin E)
8 - Water Temperature Switch (For Audio Warning) (Pin H)
9 - Distributor Wire (Pin G)
10 - Distributor Wire (Pin I)
11 - Ignition Module Grd (–) Wire (Pin J)
12 - Ignition control (trigger) wire (Pin L)
13 - Timing Lead (for setting timing and other tests)

Thunderbolt V - Service Procedures

Following is a list of some of the basic procedures that differ from the Thunderbolt IV system:

- Setting Base Ignition Timing
- Adjusting Idle Mixture
- Adjusting Engine Idle Speed

Setting Base Ignition Timing

1. Connect timing light to number 1 spark plug. Connect timing light power supply leads (if applicable) to 12 volt source.
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and run at normal idle speed. Allow engine to reach normal operating temperature.
5. Aim timing light at timing tab, located on the timing gear cover and crankshaft torsional dampener.
6. Adjust timing using the conventional method.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not function.

7. Make sure that the distributor has been tightened. Remove the jumper wire from the timing terminal.
8. Stop engine and remove timing light.

Adjusting Idle Mixture

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode”.

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
2. Adjust idle mixture following the procedure in the appropriate engine service manual.
3. Remove the jumper wire from the timing terminal.

Adjusting Engine Idle Speed

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

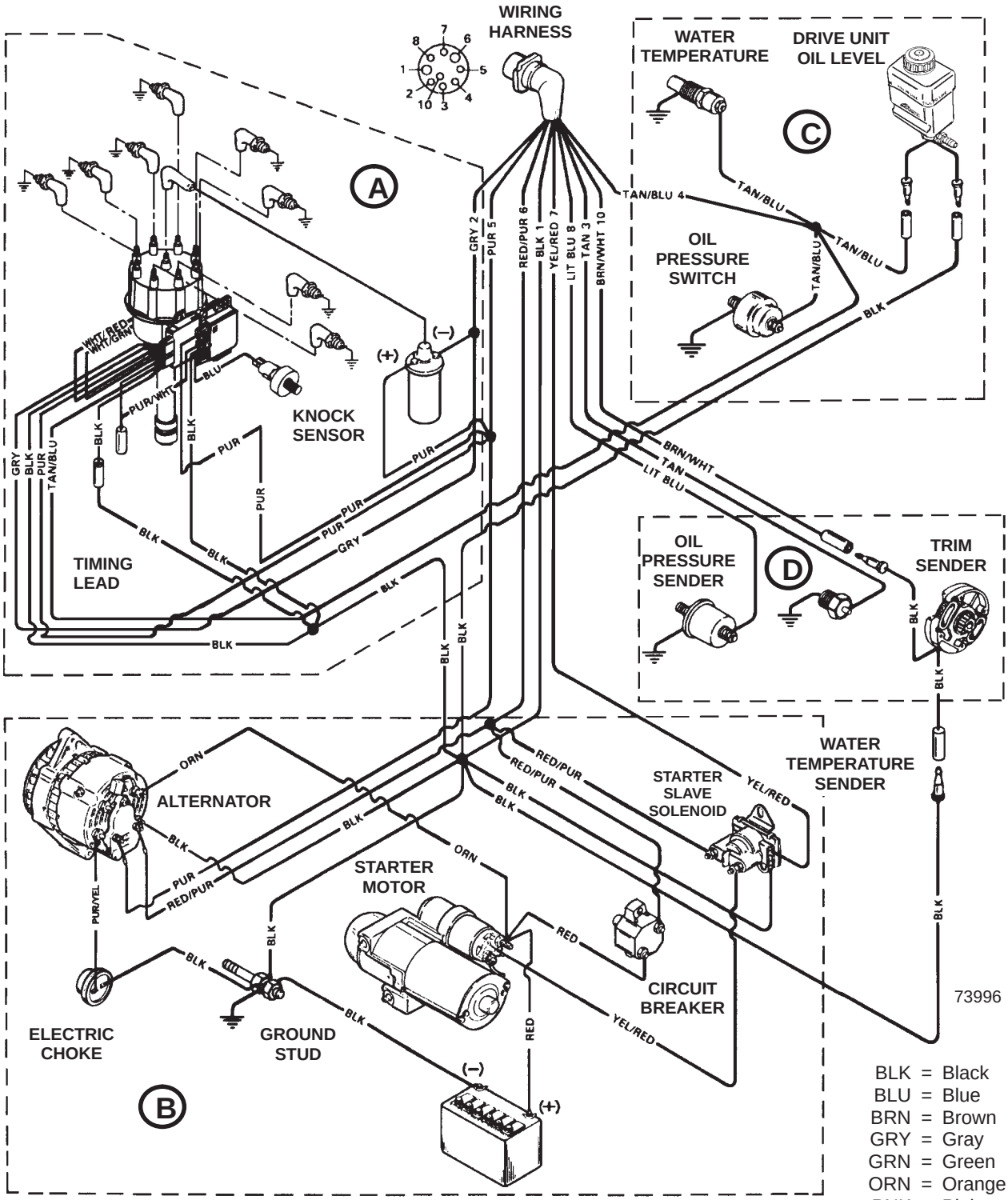
IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the "Base Timing Mode". This is necessary because of the "Idle Speed Control" feature that exists in the ignition module. See information on the previous pages about this feature.

2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead "13" (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the "Base Timing Mode".
4. Start engine and allow it to reach normal operating temperature. Place the remote control lever in forward gear, idle position.
5. Adjust idle speed to recommended RPM.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the "Base Timing Mode". This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Thunderbolt V Engine Wiring Harness Diagram



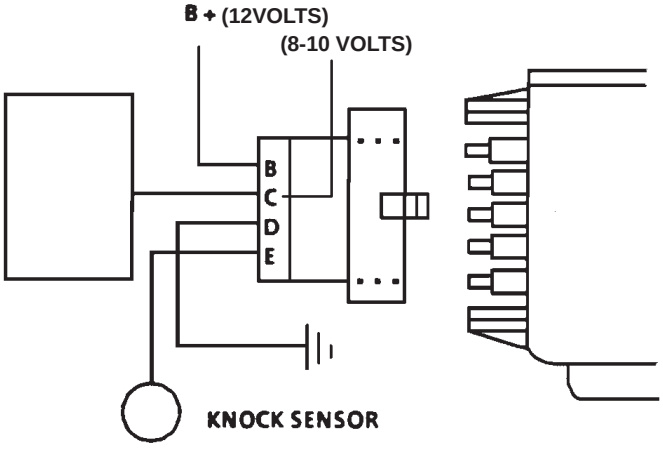
A: Ignition
B: Starting, Charging, and Choke
C: Audio Warning System
D: Instrumentation

BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

Knock Control Module

The Knock Control Module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the Ignition Control Module. If spark knock is present, the Knock module will remove the 8-10 volt signal to the Ignition Control Module.

It is extremely important that the correct knock module and sensor be used for the engine application. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage. The Knock module terminal B is powered by 12 volts from the ignition switch. If the 12 volt power source is not present, the Knock module cannot send an 8-10 volt signal to the Ignition Control Module and a false constant spark retard will result.



Knock Sensor System

Terminal "E" of the Knock module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the Knock module will never remove the 8-10 volt signal from terminal "C" to and no spark retard will occur. The ground circuit for the Knock module is connected to terminal "D". If the ground circuit opens, the Knock module will not be able to remove the 8-10 volt signal and spark knock cannot be controlled.

IMPORTANT: If knock sensor wire is routed too close to secondary ignition wires, the Knock module may see the interference as a knock signal, resulting in false timing retard.

IMPORTANT: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false knock retard signal. If fuel octane is too high or too low, a false signal can also be sent.

Testing Knock Module and Sensor

NOTE: *A digital volt-ohmmeter (DVOM) and an unpowered test light (low power test light - 300mA or less) are needed to conduct the following test.*

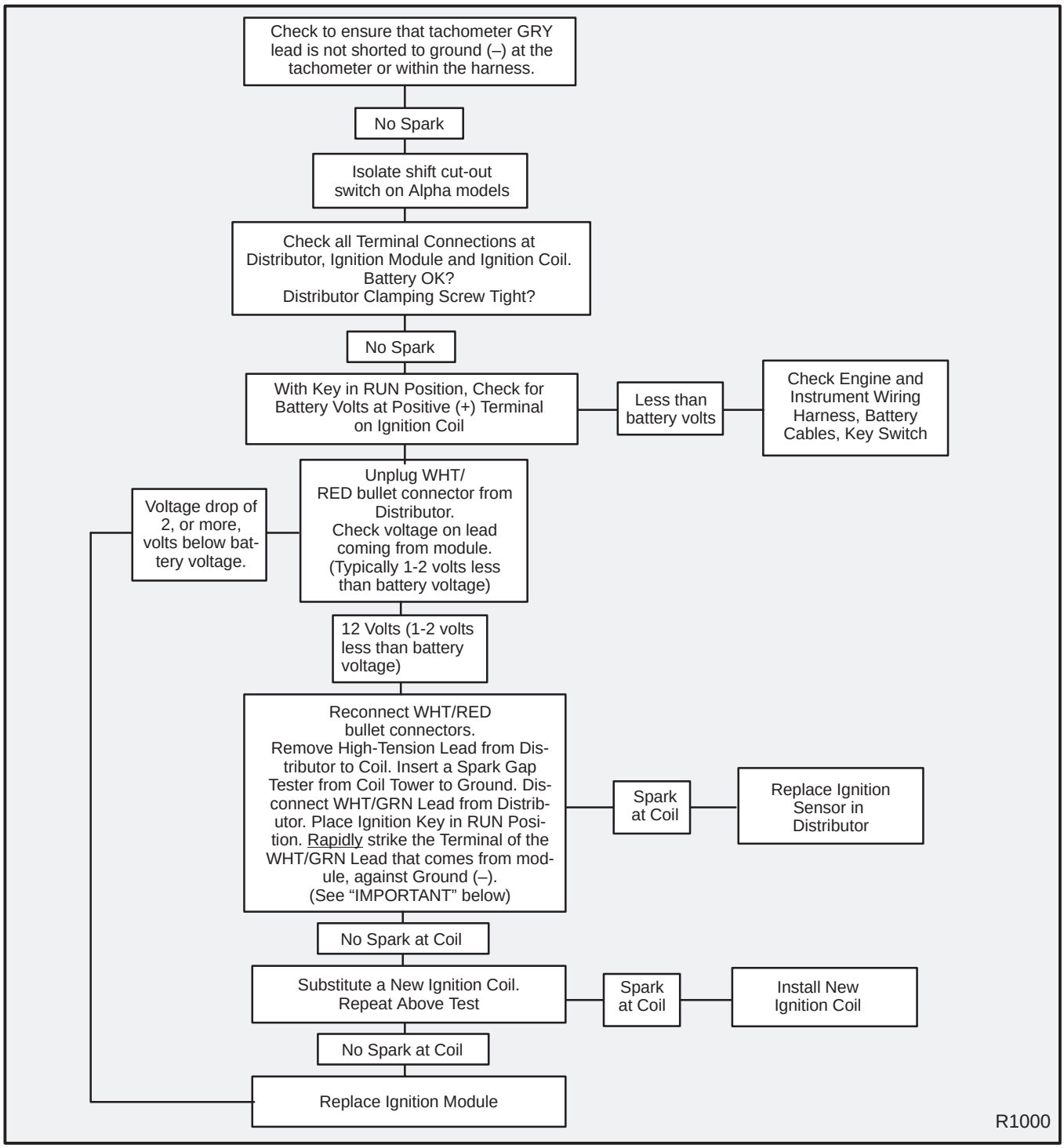
⚠WARNING

Avoid fire or explosion. Ensure that engine compartment is well ventilated and gasoline vapors are not present when performing electrical tests inside the engine compartment. Sparks generated by electrical tests could ignite gasoline vapors causing fire or explosion.

1. Start engine and warm it up to normal operating temperature.
2. Connect the positive (+) lead from the DVOM to the PURPLE/WHITE timing terminal that comes from the engine harness (see previous wiring diagram). Connect the negative (–) lead from the DVOM to a good engine ground (–). With the engine running, there should be 8-10 volts on this circuit. If voltage is not present, check to ensure that there is 12 volts to the knock module (PURPLE wire Terminal “B”).
3. Advance the throttle to approximately 1500 RPM.
4. Disconnect the harness connector (BLUE wire) from the knock sensor. Connect the unpowered test light to a positive (+) 12 volt source. To simulate an AC voltage, rapidly tap the knock sensor harness terminal with the test light. If knock module and wiring is functioning properly, you should see a voltage drop on the DVOM. If a voltage drop is not seen, check the BLUE wire from the sensor to the knock module for a short or open circuit. If the circuit is functioning properly to this point, the knock sensor may not be functioning. Proceed to the following step.
5. Reconnect the knock sensor harness connector to the sensor.
6. While still watching the DVOM, lightly and rapidly tap on the engine block near the knock sensor with a small hammer. If the knock sensor is functioning properly, you should see the voltage decrease. If a voltage drop is not seen, the knock sensor is faulty.

Troubleshooting Thunderbolt V Ignition

IGNITION CONTROL MODULE / COIL / DISTRIBUTOR


Check to ensure that tachometer GRY lead is not shorted to ground (–) at the tachometer or within the harness.
No Spark
Isolate shift cut-out switch on Alpha models
Check all Terminal Connections at Distributor, Ignition Module and Ignition Coil. Battery OK? Distributor Clamping Screw Tight?
No Spark
With Key in RUN Position, Check for Battery Volts at Positive (+) Terminal on Ignition Coil
Less than battery volts
Check Engine and Instrument Wiring Harness, Battery Cables, Key Switch
Unplug WHT/ RED bullet connector from Distributor. Check voltage on lead coming from module. (Typically 1-2 volts less than battery voltage)
Voltage drop of 2, or more, volts below battery voltage.
12 Volts (1-2 volts less than battery voltage)
Reconnect WHT/RED bullet connectors. Remove High-Tension Lead from Distributor to Coil. Insert a Spark Gap Tester from Coil Tower to Ground. Disconnect WHT/GRN Lead from Distributor. Place Ignition Key in RUN Position. Rapidly strike the Terminal of the WHT/GRN Lead that comes from module, against Ground (–). (See "IMPORTANT" below)
Spark at Coil
Replace Ignition Sensor in Distributor
No Spark at Coil
Substitute a New Ignition Coil. Repeat Above Test
Spark at Coil
Install New Ignition Coil
No Spark at Coil
Replace Ignition Module
R1000

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Test Equipment

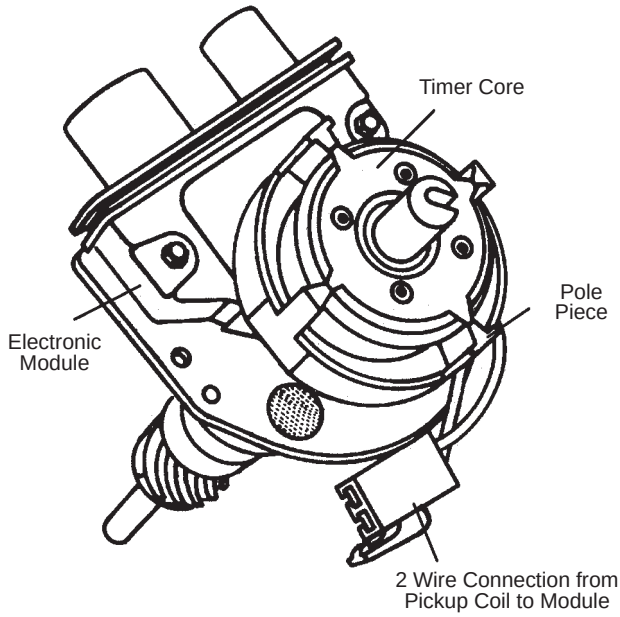
Electrical Test Equipment Service

If you need any of your Quicksilver electrical test equipment serviced, check Service Bulletin #97-13 for the vendor repair addresses.

3.0L EST Ignition System Operation

EST Ignition 3.0L/3.0LX

To provide primary current for the ignition coil EST uses a magnetic pulse generator and an electronic module. The pulse generator consists of a timer core on the main distributor shaft and a pole piece around the outside. The magnetic pole piece is designed with the same number of internal teeth as engine cylinders (4 cylinder engines = 4 teeth). The timer core rotates inside of the pole piece and has an equal number of external teeth. As the internal and external teeth start to align, voltage output from the magnetic pickup coil increases, as the teeth align and pass each other the voltage reverses polarity and decreases. As the distributor shaft rotates, the pickup assembly produces AC voltage.

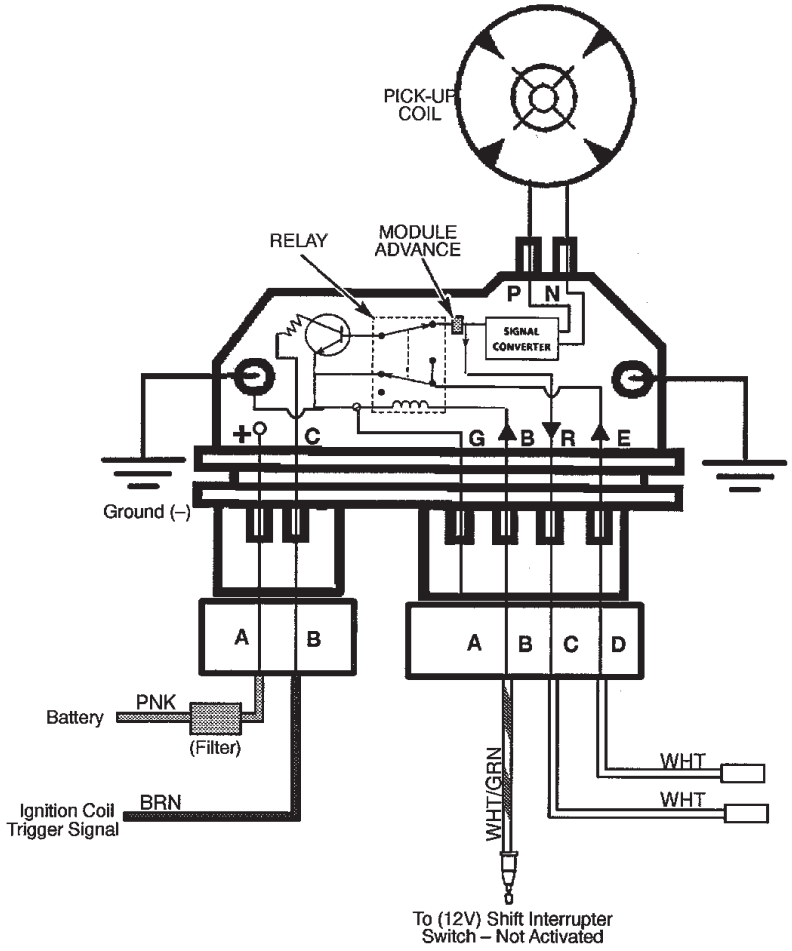


Distributor Assembly (4 cyl. shown)

3.0L EST Circuits

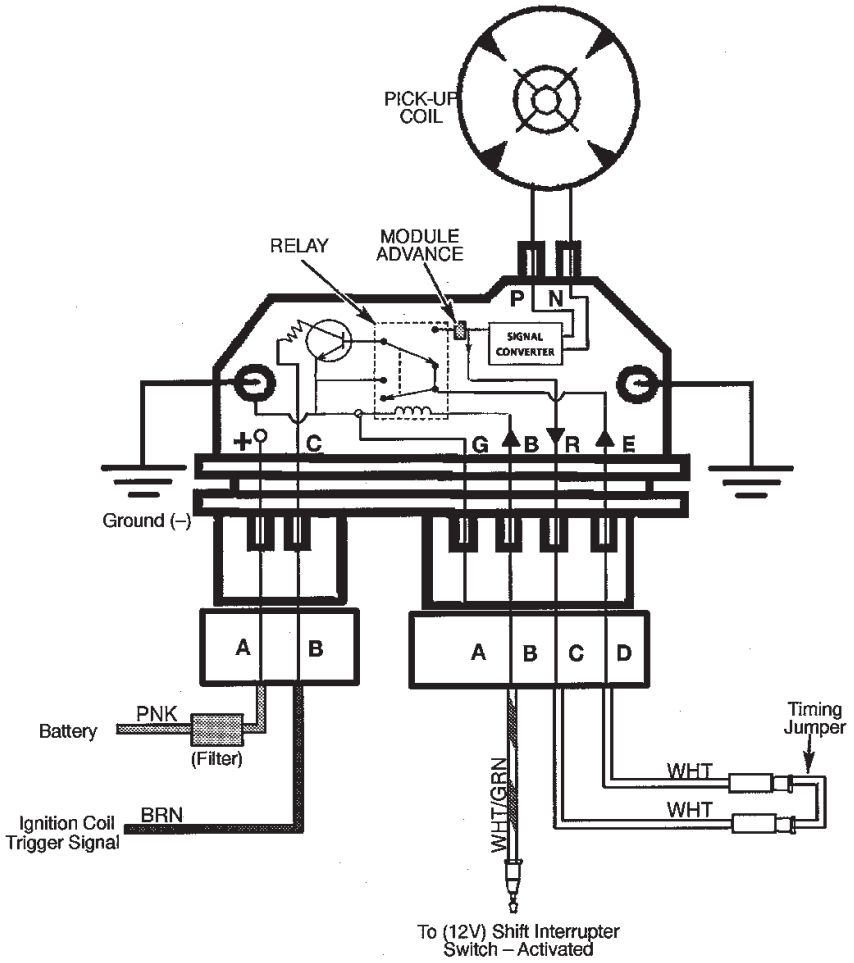
To help understand how EST circuits operate, a relay with a double set of contact points is shown. Solid state circuitry is used in the module, but adding the relay makes it easier to visualize. On the 3.0L/3.0LX models with the engine running the relay is in the de-energized state. This connects the pickup coil to the base of the transistor. The voltage output from the magnetic pickup assembly is used to turn the transistor, in the module, “on” and “off”. A transistor has polarity, so as a result, it turns on like a switch, but only when the polarity is correct to flow through itself in one direction only. When the time core teeth start to approach the pole piece teeth, voltage rises closing the transistor and allowing current to flow through the primary ignition coil to ground. As the pole pieces align and pass, the polarity of the pickup voltage begins to reverse. As the polarity reverses the transistor will turn off, causing the current to stop flowing through the primary ignition coil windings. The exact moment the transistor is turned off, there is a spark in a cylinder.

The length of time there is current flowing through the coil is called dwell. Dwell is measured in terms of degrees of distributor rotation. As the engine RPM increases, the time available for dwell is decreased, causing the secondary (coil) output to decrease. To help reduce this as engine RPM increases, the dwell increases by starting the ground path of the primary earlier, so as not to affect ignition timing. The module monitors the amperage required by the ignition coil and alters the ground path.



Ignition Control Module - Engine Running

Advance will occur below 1000 rpm, to set initial timing the advance must be disabled. On the 3.0/3.0LX bypassing the interrupter switch energizes the relay, causing the points from the pickup coil as well as the grounding points to open. By connecting a jumper between the white wires from the distributor, a pulse is pulled from the signal converter and routed to the transistor. This bypasses the timer circuit and disables the advance.

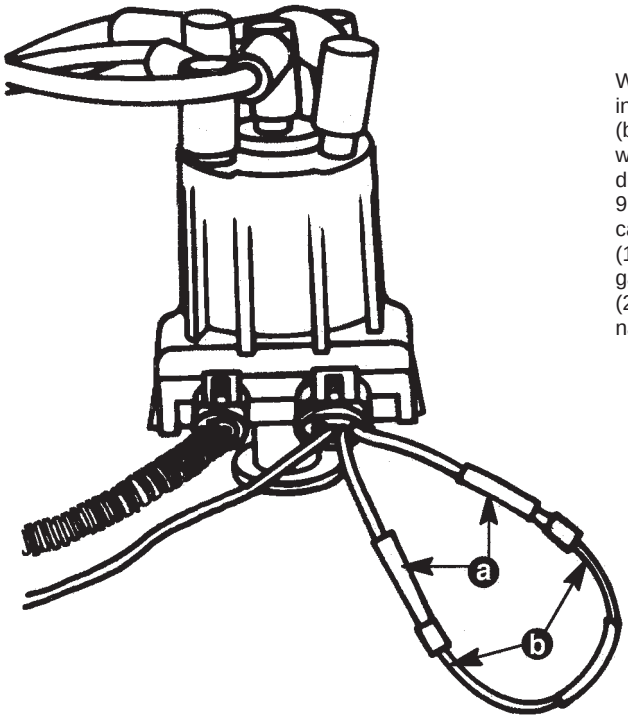


Ignition Control Module - Timing Bypass

TIMING PROCEDURE 3.0L/3.0LX WITH EST IGNITION

IMPORTANT: Failure to follow the timing procedure instructions will result in improper timing causing performance problems and possible severe engine damage.

1. Start engine and allow to reach operating temperature.
2. With engine running, install a jumper wire (b) across the two (2) white leads (a) on the distributor using P/N 91-818812A1, or fabricate one using a 6 in. (150mm) section of 16 gauge wire with two (2) male bullet terminal ends connected.



With engine running, install a jumper wire (b) across the two (2) white leads (a) on the distributor using P/N 91-818812A1, or fabricate one using a 6 in. (150mm) section of 16 gauge wire with two (2) male bullet terminal ends connected.

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3. Bypass the shift interrupt switch by disconnecting wires at shift interrupt switch and temporarily joining together.

IMPORTANT: Do not fail to reconnect these two wires to the shift interrupt switch when timing procedures are complete.

4. With timing light connected, check timing. Timing should be:

S/N 0L096999 and below:	1 degree BTDC
S/N 0L097000 - 0L340999:	1 degree ATDC
S/N 0L341000 and above:	2 degrees ATDC

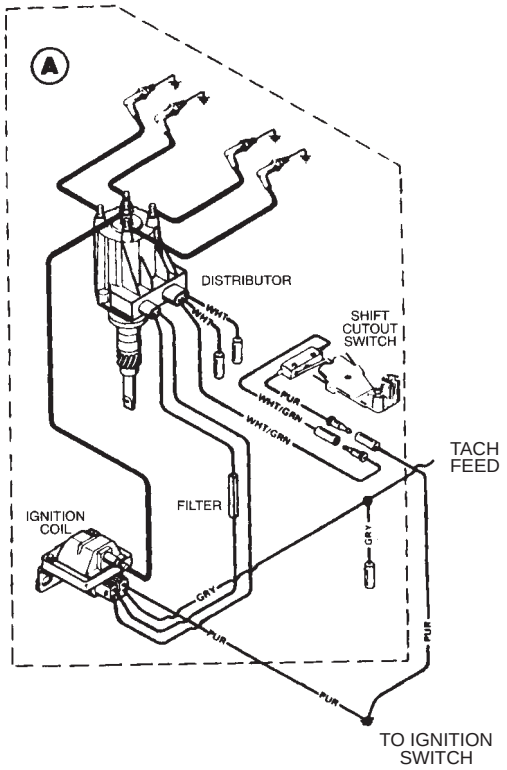
5. If required, loosen distributor hold down clamp and rotate distributor to obtain specified timing.
6. Secure distributor hold down clamp, and recheck timing as above.
7. Reconnect the two wires to the shift interrupt switch. Remove jumper wire at distributor white leads.

IMPORTANT: Be sure to remove jumper wire before returning engine to service, otherwise timing will not advance.

8. With timing light still connected, and engine at IDLE, verify that timing did advance to:

Base Timing	Idle Timing	2400-2800 rpm
1° BTDC	12° BTDC	23° BTDC
1° ATDC	10° BTDC	21° BTDC
2° ATDC	9° BTDC	20° BTDC

On 3.0L/3.0LX models a filter is installed in the battery wire (pink) between the coil and ignition module inside the distributor. This prevents an engine misfire if the trim motor is activated with the engine running.



Delco EST Ignition Troubleshooting

Erratic Spark Symptoms

1. If the erratic spark occurs only when the engine is warm, or is especially bad on warm days, remove the ignition module and make sure that plenty of thermal transfer compound is present on the module's base. The module will misfire if it is too hot.
2. Verify that the purple power lead (carbureted) or red power lead (EFI) to the ignition coil is holding steady battery voltage during the erratic spark (misfiring) event. If not, check the key switch and safety lanyard switch for loose connections or internal failure.
    a. Try isolating the boat harness with a shop test harness (the 3-foot MerCruiser harness – part #84-812475A3 and MerCruiser ignition switch assembly – part #54212A7). If the problem disappears, the problem is in the boat harness, not the MerCruiser engine harness.
    b. There are several splices in the purple lead on almost all MerCruiser engines, so it may be necessary to go into the engine harness to find the loose connection. On an EFI engine, ignition coil power comes from the system relay.
3. If the purple (or red) power lead to the coil holds steady voltage, carefully flex the pink and brown harness (between the coil and the ignition module) while the engine is running. If the engine runs better or quits, replace the harness between the coil and ignition module. This is usually because the filter in the pink lead has failed.
4. If erratic spark is still present, isolate the gray (carbureted) or white (EFI) tach lead at the negative side of the ignition coil. Use a suitable jumper lead to jump the purple (or red) lead to the ignition coil and leave the tach lead disconnected. Kent-Moore Jumper Lead Kit #J-35616 works well, or you can cut the gray (or white) tach lead near the ignition coil and install a bullet connector from Quicksilver connector kit part #86-813937A2. If the engine now runs better, tach lead is partially shorted to ground in the engine harness, boat harness or in the tach itself.
5. If erratic spark is still present, troubleshoot the secondary system with a Kv meter.

No Spark Troubleshooting:

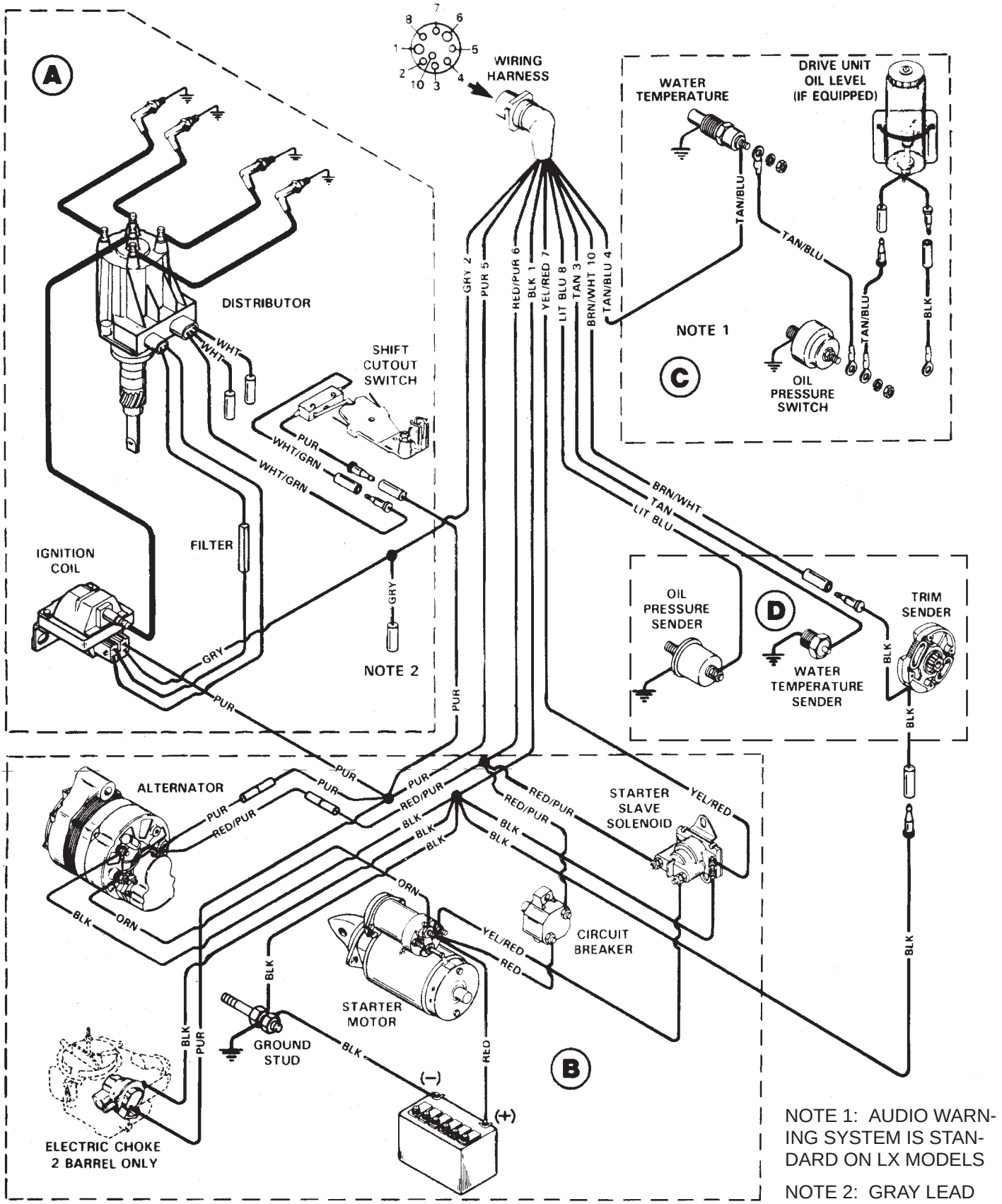
1. Visually check the ignition coil for melted plastic on its outer case. If the case is melted, the tachometer lead (gray or white) is shorted to ground somewhere. Isolate and repair before replacing the ignition coil.
2. Make sure that battery voltage is present at the purple power lead (carbureted) or red power lead (EFI) at the ignition coil. If not, isolate and repair the problem in the engine or boat harness.
3. Isolate the gray (carbureted) or white (EFI) tach lead at the negative side of the ignition coil as described in the previous section, step 4. If spark is now present, the tach lead is shorted to ground in the engine harness, boat harness or in the tach itself.
4. Disconnect the 4 pin connector from the ignition module.

Carbureted models: if spark is now present, the shift cut-out switch is stuck on or shorted closed. Replace the switch and retest.

EFI models: if spark is now present, the ECM is sending bypass voltage to pin "B" of the ignition module and it is not supposed to. The EFI system will have to be diagnosed at this time, as there is not a problem with the EST system.

5. Disconnect the 2-pin connector from the ignition module. With the Key ON, check for battery voltage at both the pink and brown terminals of the harness.
    a. If there is not battery voltage at the pink terminal, replace the 2-wire harness as the filter is most likely blown open.
    b. If there is not battery voltage at the brown terminal, replace the ignition coil as the primary windings have most likely melted open (because of a shorted tach lead).
6. If spark is still not present, remove the distributor cap and check the pickup coil for resistance and short-to-grounds. Resistance across the green and white leads must be 500-1500 ohms (750-850 preferred) and the reading must be steady. Resistance between the green lead and the distributor frame must be “infinity” and resistance between the white lead and the distributor frame must be “infinity”. If any of these readings differ from specifications, replace the pickup coil.
7. Verify that the timer core is still magnetic. This is the part that rotates above the pickup coil.
8. If spark is still not present, you will need to “false trigger” the module to determine if it is opening and closing the primary circuit. Proceed as follows:
    a. If still isolated, reconnect the tach lead to the ignition coil. Connect a voltmeter to the gray tachometer lead bullet connector (near the ignition coil). Set the meter to read DC volts. Connect an air gap tester from the coil’s secondary terminal to ground.
    b. Remove one of the ignition module mounting screws and loosen the other. Rotate the module out from the distributor frame, then retighten the loose screw. Connect the positive lead from a 1.5 volt AA (or similar) battery to the ignition module’s “P” terminal (pickup coil terminal).
    c. With the key in the ON position, note the voltmeter reading. It must be battery voltage. If not, you didn’t verify the coil primary windings are good or you didn’t find the short to ground in the gray tach lead. If the voltage is OK, proceed.
    d. While observing the voltmeter, **momentarily** connect the negative lead of the 1.5 volt battery to the distributor frame. The voltage must drop several volts as the module grounds the negative side of the coil. If not, replace the ignition module.
    e. When the negative battery lead is disconnected from the distributor frame, the voltage must rise back to battery voltage and the ignition coil should fire. If the voltage changes, but the coil does not fire, replace the ignition coil (the secondary windings are open or shorted).
    f. When finished, reconnect all leads and connectors.

MCM 3.0L/3.0LX (EST Models) Engine Wiring Diagram



NOTE 1: AUDIO WARNING SYSTEM IS STANDARD ON LX MODELS

NOTE 2: GRAY LEAD FOR USE WITH SERVICE TACHOMETER

A: Ignition and Choke System
B: Starting and Charging System
C: Audio Warning System
D: Instrumentation System

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EFI Engines with High Energy Ignition and Electronic Spark Timing (EST)

The Electronic Fuel Injection (EFI) is controlled by an Electronic Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The EFI system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The EFI system has been designed to control ignition advance and retard electronically by the ECM. This electronic advance becomes much more exact and reliable, just as EST is more exact and reliable when compared to the breaker point-ignition system.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the EST module which converts the pickup coil voltage to a square wave (digital) reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. The ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the EST module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

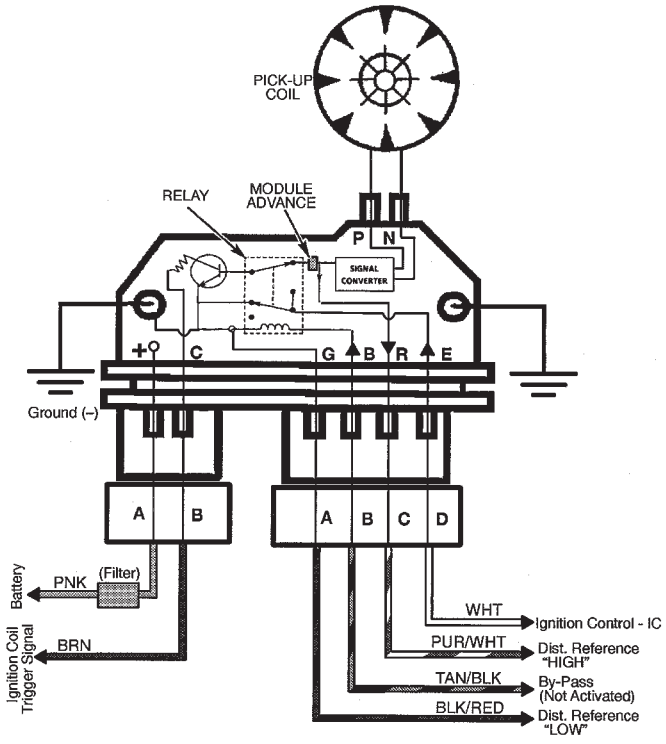
The two other lines between the ECM and distributor which control the Electronic Spark Timing (EST) operation are known as the bypass and IC (Ignition Control) circuits.

EST Operation – Cranking (Distributor Module Mode)

The following describes EST operation during cranking and when the engine starts running. To help understand how EST circuits operate, a relay with a double set of contact points is shown in the HEI module (refer to the figures “Distributor Module Mode” and “ECM Control Mode”). Solid state circuitry is used in the module, but adding the relay makes it easier to visualize how EST functions.

During cranking, the relay is in the de-energized position (see figure “Distributor Module Mode”). This connects the pickup coil to the base of the transistor. When the pickup coil applies a positive voltage to the transistor, it turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the EST module via a timing circuit, in case the engine remains in the distributor module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the EST (IC) line signal.

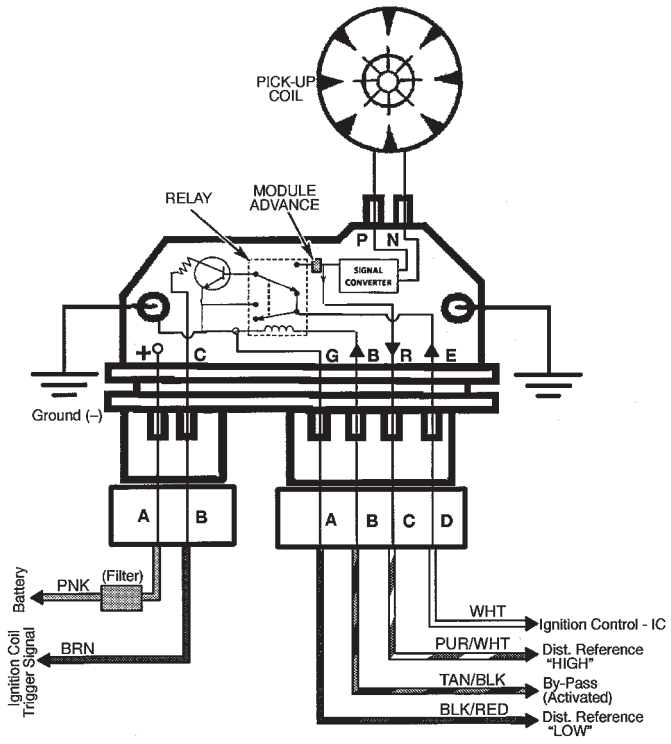


Distributor Module Mode

EST Operation - Engine Running (ECM Control Mode)

When the engine RPM reaches a predetermined value (for this example, 300 RPM), the ECM considers the engine running and applies five volts on the bypass line to the EST module. This energizes the relay and causes the points from the pickup coil as well as the grounding points for the IC (Ignition Control) line to open (see figure “ECM Control Mode”). This connects the IC (Ignition Control) line to the base of the power transistor, and bypasses the ignition module timing control.

The EST system is now controlled by the IC (Ignition Control) signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM. This is called the ECM Control mode.

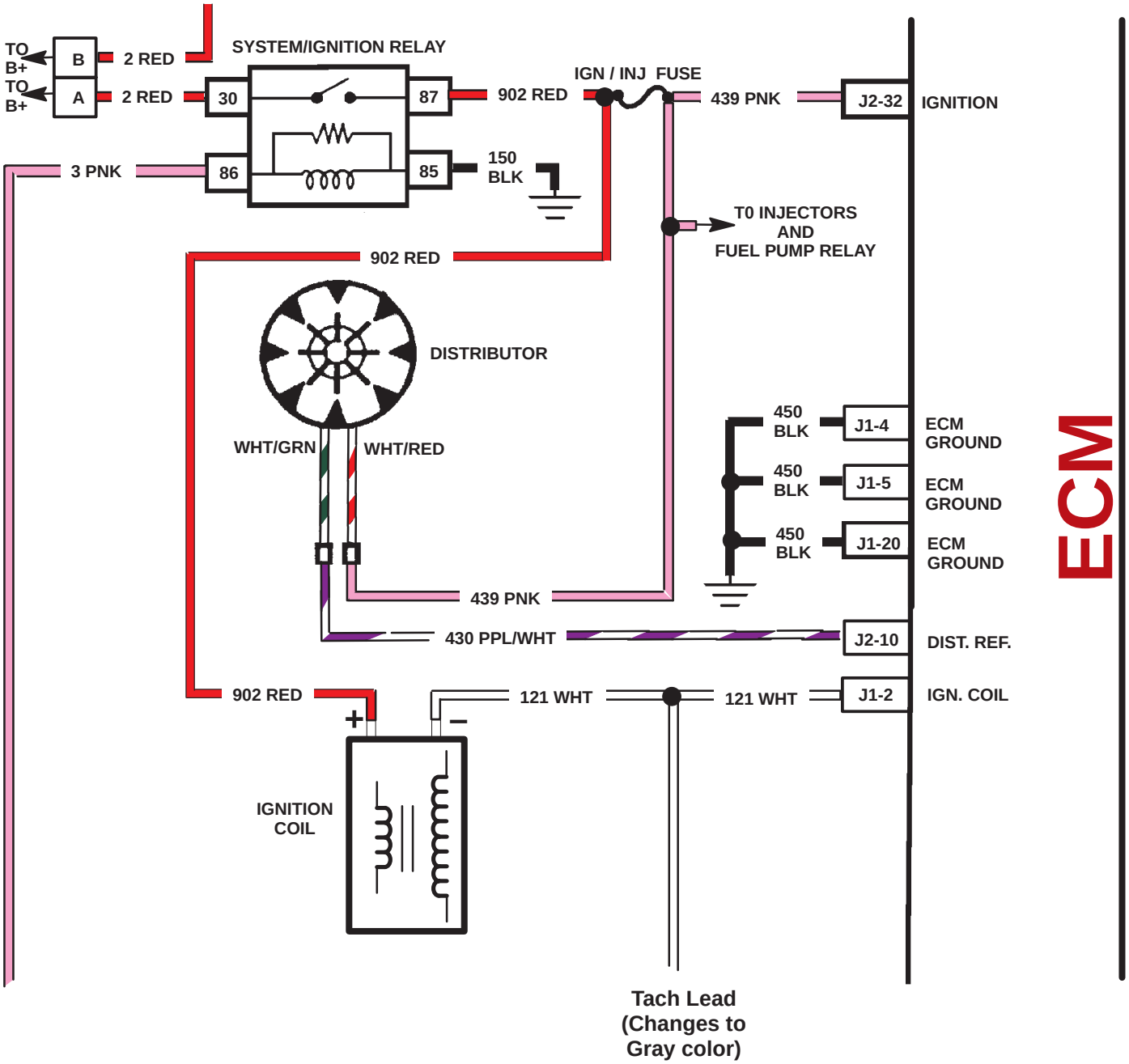


ECM Control Mode

EFI Engines with Mercury Marine (Thunderbolt V) Distributor and MEFI-3 ECM - 1999 V-6 and Small Block V-8 Engines

These EFI/MPI engines (V-6, Small Block V-8) originally used an EST type of distributor. They now use (1999 and later) a Mercury Marine, Thunderbolt V style distributor. This unit only has an ignition sensor. It does not have an ignition module like the EST system.

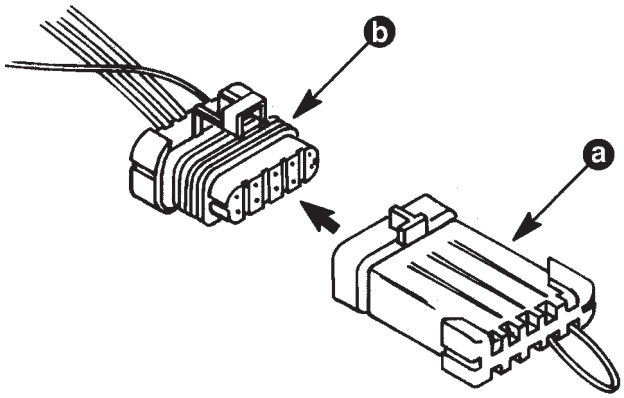
The sensor provides a square wave (digital) signal to the ECM, which is used as an engine speed reference (rpm) and as a timing reference. The ECM completely controls ignition timing at all engine speeds. This is similar to an EST ignition running in the “ECM Control Mode.” The ignition coil driver (transistor), which was built into the EST ignition module, is now inside the MEFI-3 ECM.



P/N 91-805747A2 Timing Tool for MerCruiser EFI Engines

IMPORTANT: The engine must be completely warmed-up to normal operating temperature before checking or adjusting timing. Also, throttle must be advanced before connecting timing tool, to avoid engine stalling [The idle air control (IAC) valve closes air passage when engine is placed in the "Service Mode" – when timing tool is installed].

1. Connect timing light to #1 ignition wire.
2. Adjust engine throttle to 1800 RPM ± 200. (Necessary on MEFI-1 ECM's only.)
3. Connect timing tool to the Assembly Line Data Link (ALDL) connector which is located in the engine electrical box.
4. Check and adjust timing in the normal manner. Remove timing tool when finished timing engine.



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a - Timing Tool
b - ALDL Connector

NOTES:

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2

E

IGNITION SECONDARY

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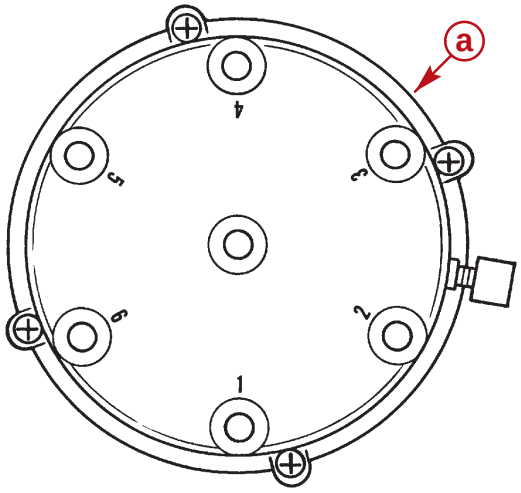
Distributor Cap

Removal

1. Loosen four distributor cap retaining screws.
2. Remove distributor cap.

Inspection

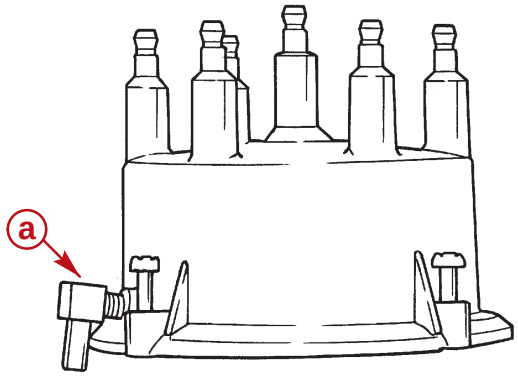
1. Clean cap with warm soap and water and blow off with compressed air.
2. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.
3. Check cap for cracks or carbon tracks using magneto analyzer.
4. Check condition of distributor cap gasket. Replace gasket if damaged or missing.
5. If high tension leads are removed from cap refer to “Spark Plug Wires” in this section and the following illustrations for installation.



72981

Wiring

a - Alignment Notch



72978

a - Vent

Rotor/Sensor Wheel

Removal

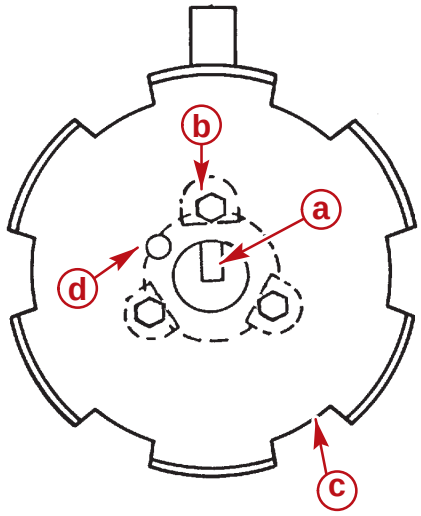
1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are secured to the shaft with Loctite. Use two flat blade screwdrivers. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry off rotor/sensor wheel assembly. The use of torch lamp will also aid in the removal of the rotor/sensor wheel assembly.

⚠ WARNING

Wear protective gloves when handling heated rotor/sensor wheel assembly to avoid severe burns.

Inspection

1. With the rotor/sensor wheel assembly removed, inspect the locating key inside the rotor.
2. The locating key will appear as a clean edged, 1/8 in. (3 mm) wide, sloped ramp at the bottom of the splined hole.

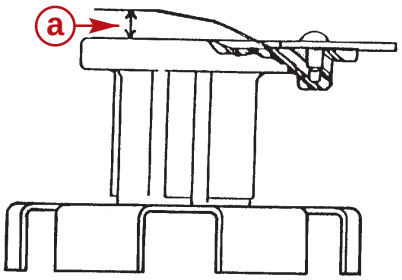


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a - Locating Key
b - Screws (Hex Head)
c - Sensor Wheel
d - Locating Pin

3. If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of the figure above with sensor fingers facing up (toward you). Line up three screw holes and locating pin hole on sensor wheel with the figure. If wheel is indexed properly all the fingers on wheel will line up with those in the figure.
4. If there are pieces of material shaved off the key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
5. Check rotor for burned or corroded center contact.
6. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.

7. If rotor is damaged, replace rotor by removing three hex bolts and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten three hex bolts securely.
8. Bend carbon brush tang upward slightly until a distance of 1/4 in. (6.4 mm) is obtained between rotor and tang.



72979

a - 1/4 in. (6.5 mm)

Installation

1. Put 2 drops of Loctite 27131 into the rotor so it lands on the locating key.
2. Put 2 drops of Loctite 27131 in keyway on upper portion of distributor shaft.
3. Immediately install rotor assembly onto distributor shaft. Make sure rotor locating key is aligned with keyway in distributor shaft before pressing rotor all the way down on the shaft, until it stops, with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.
4. The rotor should fit very tight. It may be necessary to heat rotor with torch lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.
5. Reinstall distributor cap on distributor.
6. Install spark plug wires (if removed). Refer to “Spark Plug Wires” in this section.

Spark Plug Wires

Checking

1. Visually inspect spark plug wires for damage, such as being cracked, cut or oil soaked.
2. Visually inspect spark plug boots for damage.

NOTE: *Use care when removing spark plug wires and boots from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

3. Check spark plug wires for continuity using a Multi-Meter, Digital/Volt/Ohm Meter, or similar. Replace any plug wires that do not show continuity from end to end.
4. Replace any damaged plug wires.

Replacing

IMPORTANT: Wire routing must be kept intact during service and followed exactly when wires have been disconnected or when wire replacement is necessary. Failure to route wires properly can lead to radio frequency interference, cross firing of the plugs, and/or shorting of leads to ground.

IMPORTANT: Use only spark plug wires recommended for Marine application.

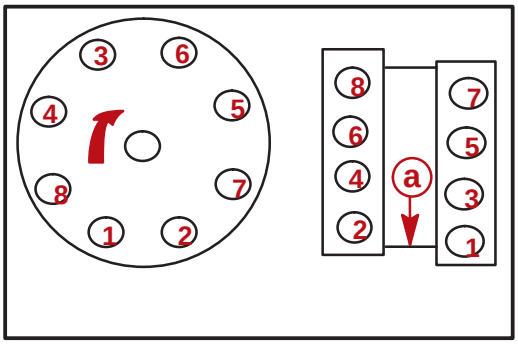
NOTE: *When replacing spark plug wires, it is good practice to replace one wire at a time to reduce the risk of error.*

1. Disconnect individual spark plug wires.
2. Install spark plug wires in proper order. Observe the following:

IMPORTANT: When replacing plug wires, route the wires correctly through the proper supports. Correct positioning of spark plug wires and supports is important to prevent cross-firing.

a. Position wires in spark plug wire supports and retainers, as provided.

b. Attach plug wires to appropriate spark plug and terminal on distributor cap. Each end should fit securely.



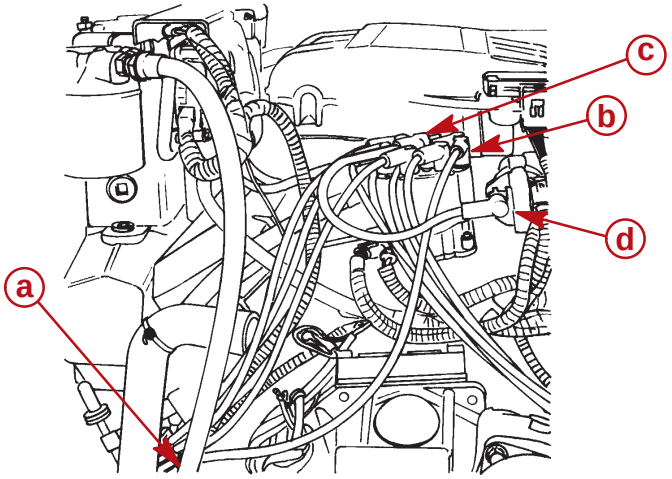
Engine Rotation And Firing Order

a - Front

IMPORTANT: Before installing coil wire (high tension lead) to coil, apply approximately 1/2 oz. of Silicone Dielectric Compound, an electrical insulating compound (Quicksilver 92-802882A1), around top of coil high tension lead tower. Do not apply to inside of tower hole.

c. Apply Silicone Dielectric Compound. Attach coil wire (high tension lead) to center terminal on distributor cap.

d. Push end of high tension wire into coil tower. Position boot over coil tower and wipe off excess insulating compound.



75634

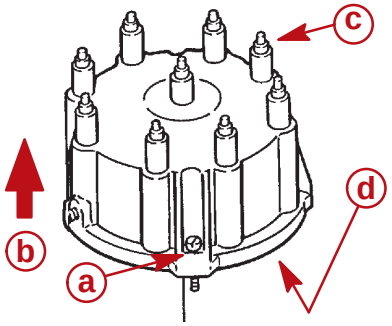
a - Wire Supports
b - Distributor Terminal
c - Distributor Coil Wire Terminal
d - Coil Tower

NOTE: *Make sure boot does not come off of tower due to hydraulic air pressure inside boot, caused during installation.*

Distributor Cap

Checking

1. To remove distributor cap:
   a. Loosen the distributor cap retaining screws.
   b. Lift cap away from distributor.
2. Check cap contacts for excessive burning or corrosion.
3. Check center contact for deterioration (worn down, burning or corrosion).
4. Visually check cap for cracks or carbon tracks. (Thin, black lines. Generally inside the cap, near contacts.)
5. If cap is acceptable, clean cap with warm soap and water and dry with compressed air. Replace if defective.



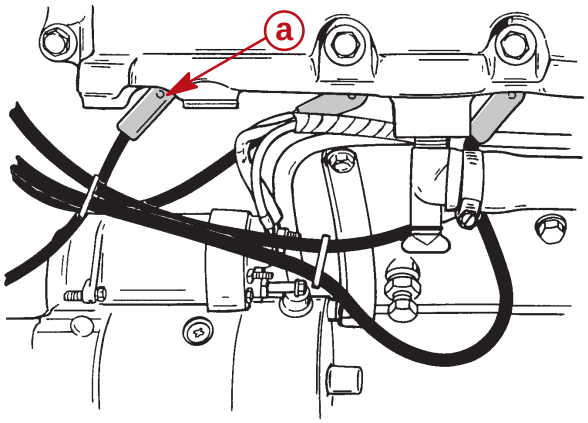
75629

a - Cap Retaining Screws
b - Lift Cap Upward
c - Cap Contacts
d - Center Contact (Inside)

Spark Plugs

Checking

1. Disconnect spark plug wires (high tension leads) from spark plugs.



74073

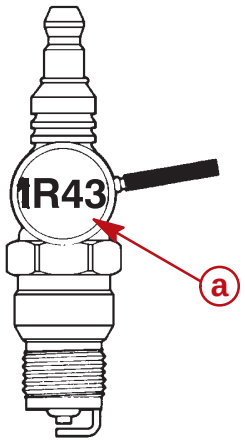
a - Spark Plug Boot

NOTE: *Use care when removing spark plug wires and boots from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

2. Remove spark plugs.

NOTE: *A "thin-walled" spark plug socket may be required.*

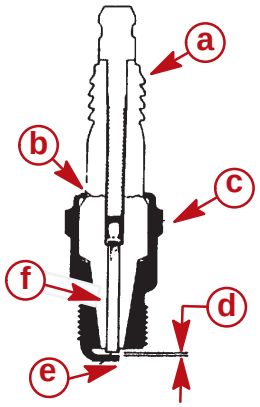
3. Inspect each spark plug for manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number. Refer to "Specifications" section for spark plug numbers, SECTION 1B.



75084

a - Spark Plug Number

4. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.



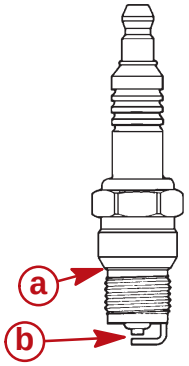
72734

a - Porcelain Insulator
b - Insulator - Cracks Often Occur at This Point
c - Shell
d - Proper Gap
e - Side Electrode
f - Center Electrode (When Adjusting Gap - DO NOT Bend)

Replacing

IMPORTANT: Tapered seat spark plugs are not interchangeable with non-tapered (with gasket) spark plugs. Do not use gaskets on tapered seat plugs.

1. Clean the plug seating area on the cylinder heads. Clean the tapered seat area of each tapered seat spark plug.
2. Adjust spark plug gap with a round feeler gauge. Bend side electrode to adjust gap. Refer to “Specifications” in SECTION 1B, for correct spark plug gap.



75084

a - Seating Area
b - Gap

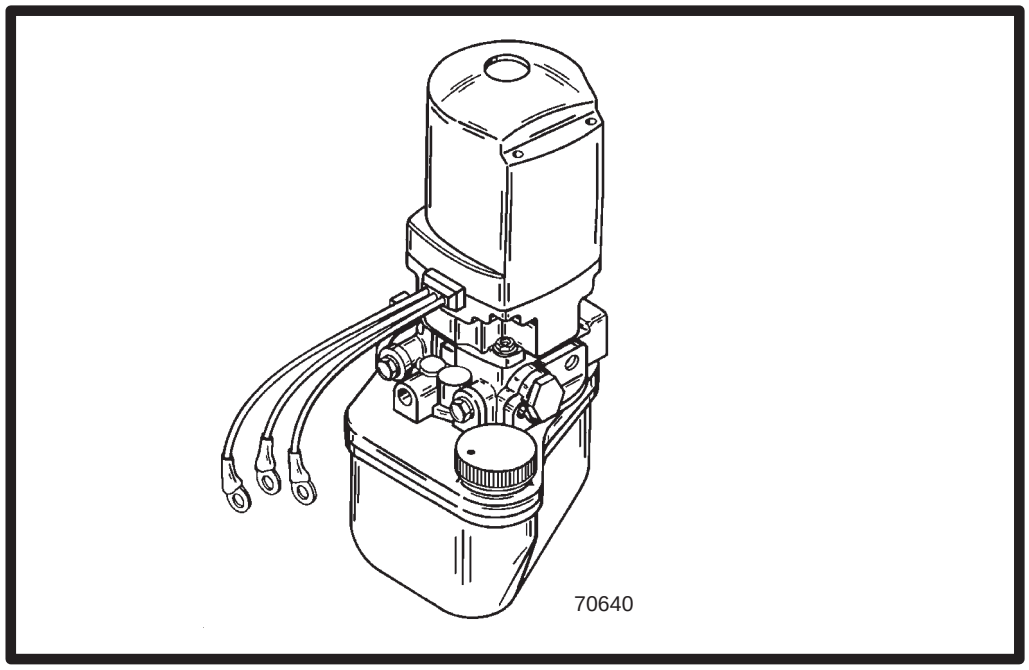
IMPORTANT: It is recommended that spark plugs be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head. Then, securely tighten with appropriate wrench and socket. On tapered seat plugs, only slight rotation (approximately 1/8 or less of a full turn) after seating, is required to create a seal and secure the plug.

3. Install spark plugs and torque to specifications. Refer to “Torque Specifications,” in this section.
4. Install spark plug wires in proper order. Refer to “Engine Rotation and Firing Order” and/or “Spark Plug Wires,” following.

NOTES:

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2
F



POWER TRIM ELECTRICAL

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NOTES:

Power Trim Electrical System Series V 1986 and Up

The “Oildyne” pump is fitted with two solenoids as standard equipment. Without the use of solenoids, the smaller gauge wire in the control handle or the additional length of wire harness, would cause too great a voltage drop for the pump motor to operate properly.

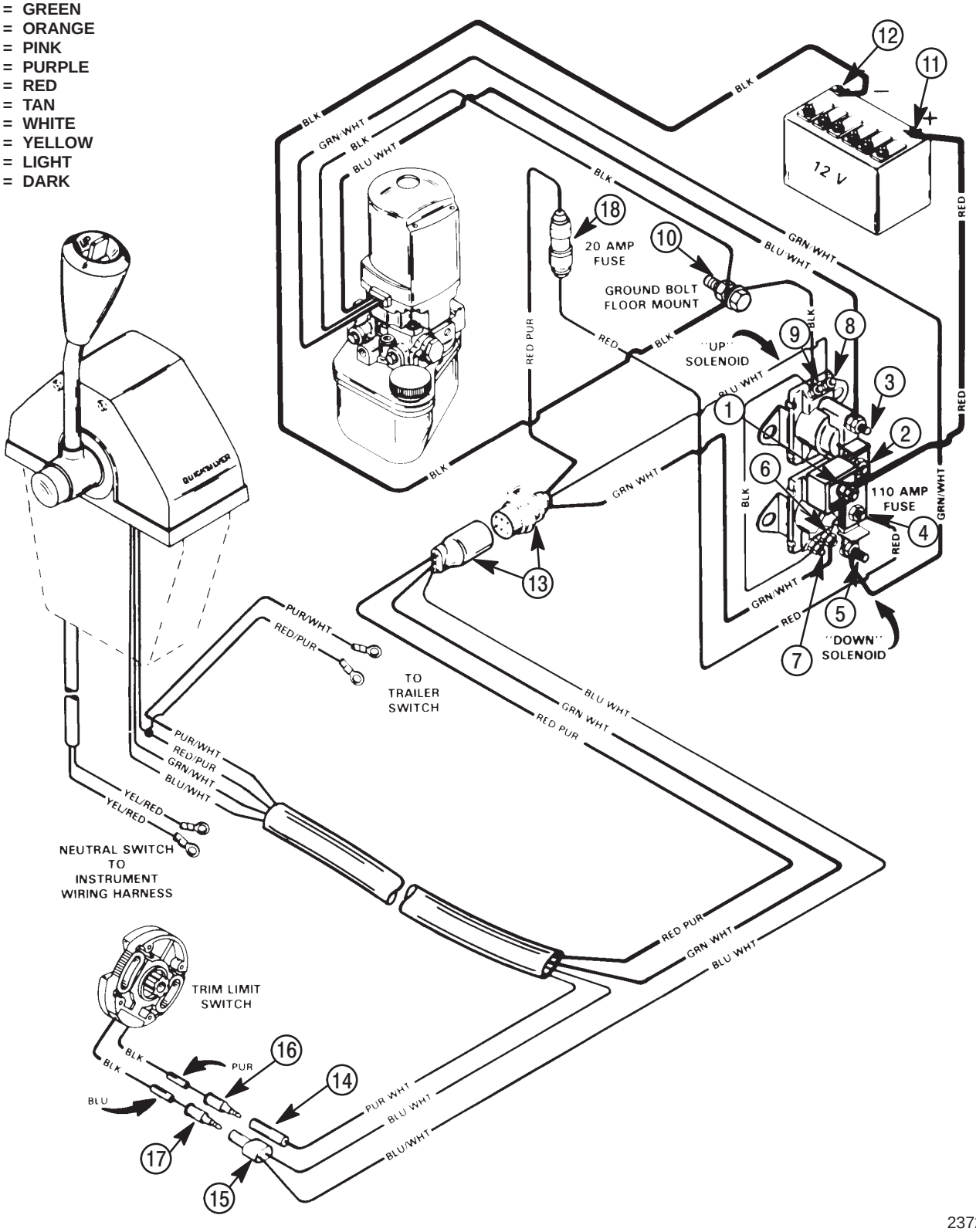
Current is supplied to the control (panel or handle) from the battery via the red lead and is protected by a 110 amp fuse located on the solenoid and then on thru the red-purple lead to a 20 amp circuit breaker (on older pumps) or a 20 amp fuse (on new pumps), which serves to protect the trim control and harness from an overload. Pushing the “up/out button” (in the control panel) or the trim switch in the control handle upward, connects the red-purple jumper lead and the purple-white lead which routes current to the trim limit switch (which is normally a closed circuit). The blue-white lead then carries the current to the “up” solenoid where it activates the solenoid to supply current via the large blue-white lead to operate the trim motor in an up direction. The “up/out button” in the control panel, or the trim switch in the control handle, allows approximately 17° of trim (from full “down” position), after which point the trim limit switch opens and current can no longer be supplied to the pump motor. By pressing the “up/out” and “up” button simultaneously or the trailer button on the control handle, this will connect the purple-white jumper lead to the blue-white lead which bypasses the trim limit switch. Current then proceeds to the “up” solenoid and allows the drive unit to travel to a full “up” position.

Pushing the “in” button (in the control panel), or the trim switch in the control handle downward, connects the red-purple jumper lead and the green-white lead. The green-white lead then carries the current to the “down” solenoid where it activates the solenoid to supply current via the large green-white lead to operate the trim motor in a “down” direction.

The pump motor is protected from overheating by an internal circuit breaker (in the field winding), which interrupts the ground circuit to the solenoids if an overheating condition is sensed.

Power Trim Wiring Diagram

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK

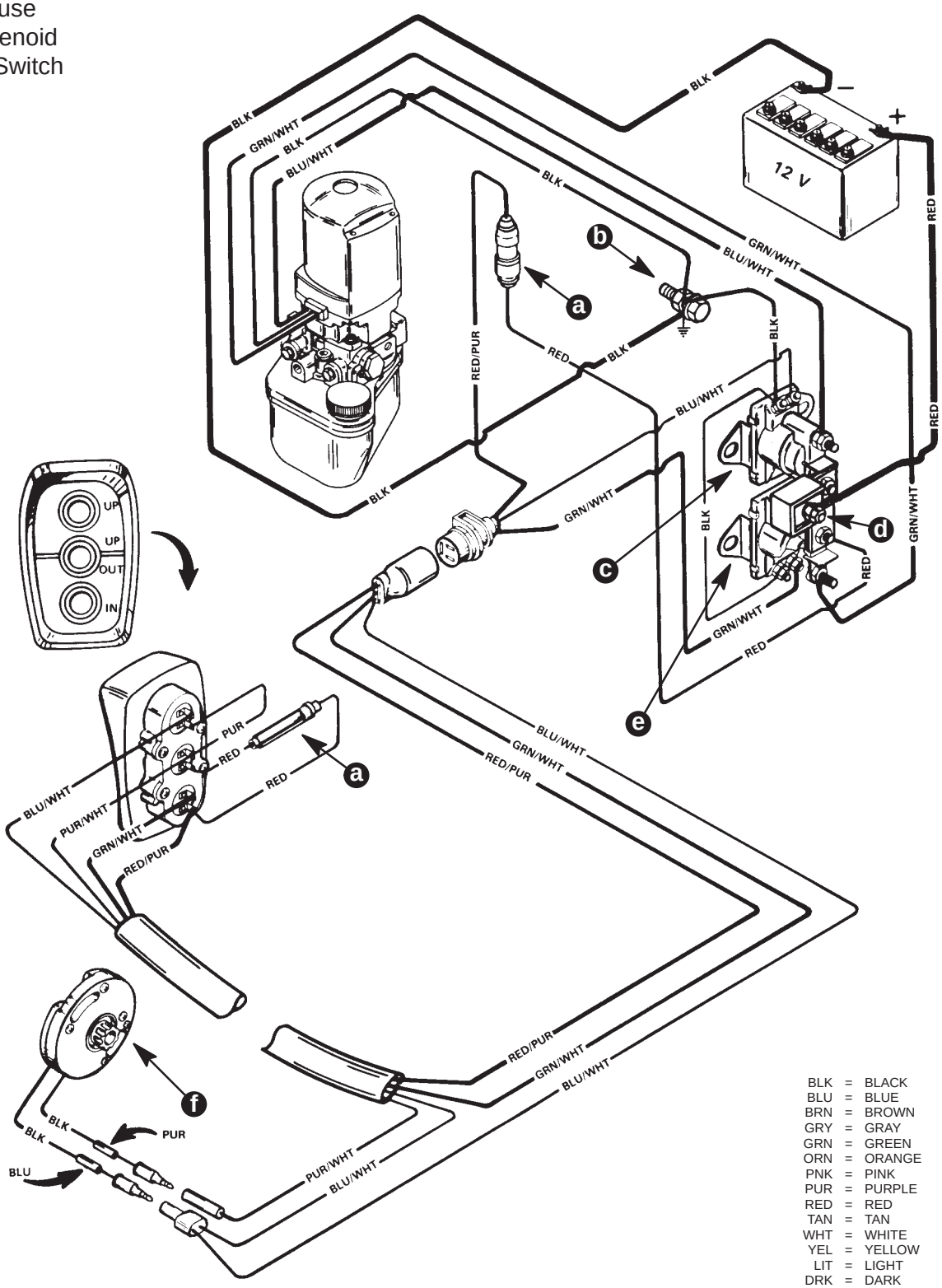


23726

Trim Pump Wiring Diagrams

Model With Three-Button Trim/Trailer Panel

a - 20 Amp Fuse
b - Ground Bolt (Floor Mount)
c - UP Solenoid
d - 110 Amp Fuse
e - DOWN Solenoid
f - Trim Limit Switch

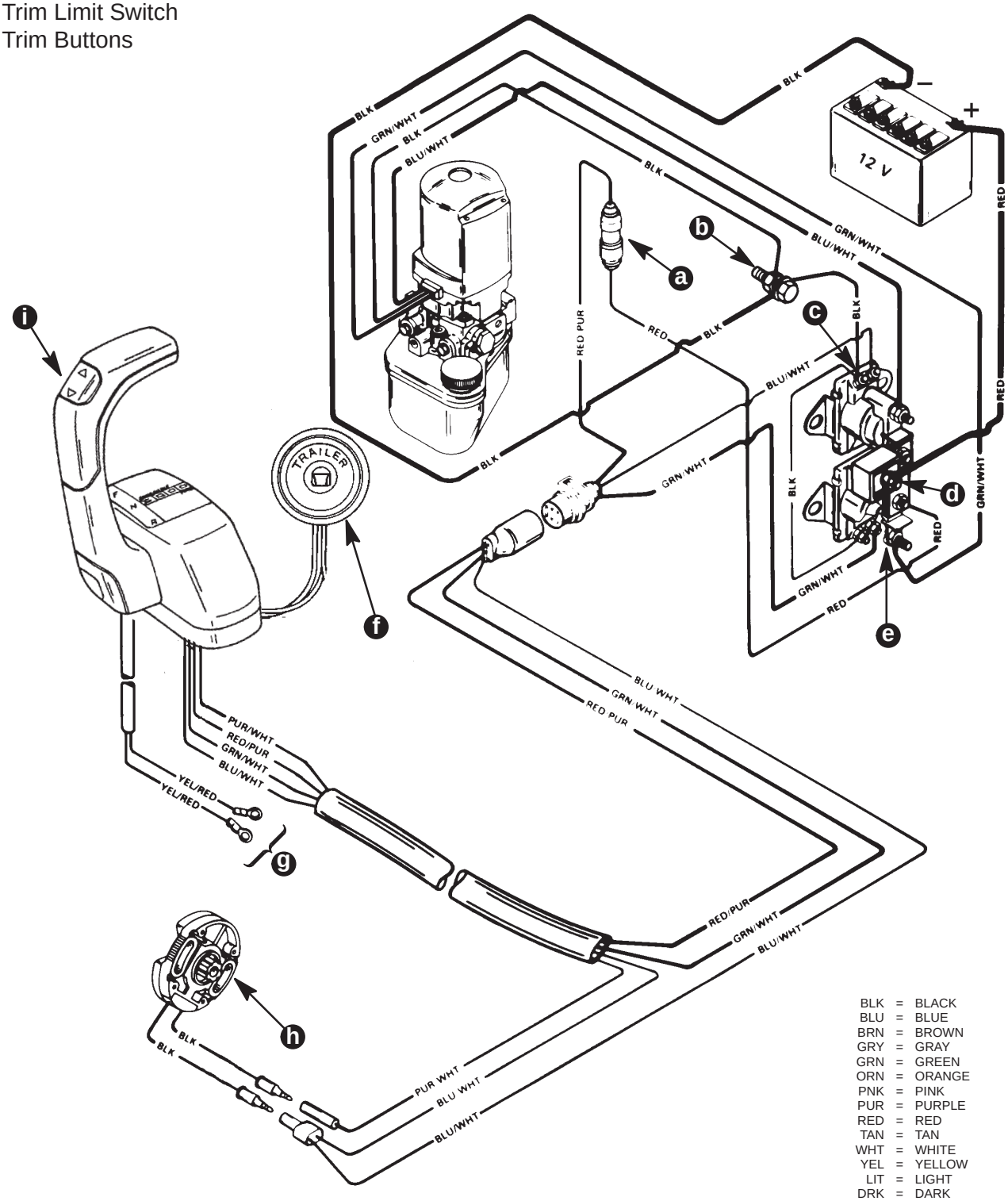


BLK	=	BLACK
BLU	=	BLUE
BRN	=	BROWN
GRY	=	GRAY
GRN	=	GREEN
ORN	=	ORANGE
PNK	=	PINK
PUR	=	PURPLE
RED	=	RED
TAN	=	TAN
WHT	=	WHITE
YEL	=	YELLOW
LIT	=	LIGHT
DRK	=	DARK

22252

Model With Trim In Handle and Trailer Switch Separate

- **a** - 20 Amp Fuse
- **b** - Ground Bolt (Floor Mount)
- **c** - UP Solenoid
- **d** - 110 Amp Fuse
- **e** - DOWN Solenoid
- **f** - Trailer Switch
- **g** - Neutral Switch To Instrument Wiring Harness
- **h** - Trim Limit Switch
- **i** - Trim Buttons

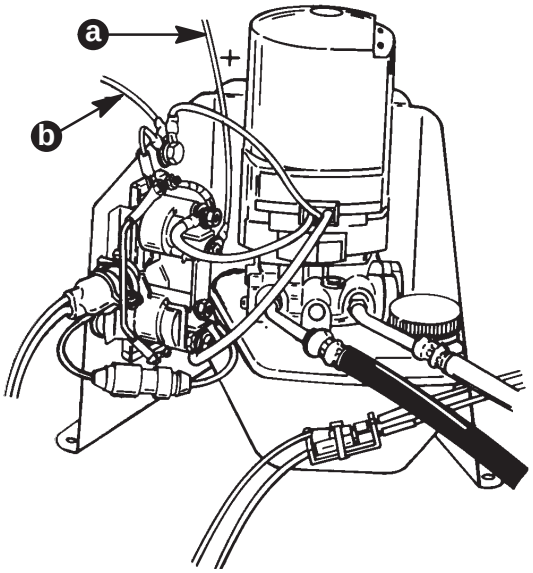


BLK	=	BLACK
BLU	=	BLUE
BRN	=	BROWN
GRY	=	GRAY
GRN	=	GREEN
ORN	=	ORANGE
PNK	=	PINK
PUR	=	PURPLE
RED	=	RED
TAN	=	TAN
WHT	=	WHITE
YEL	=	YELLOW
LIT	=	LIGHT
DRK	=	DARK

73962

Trim Position Sender Adjustment

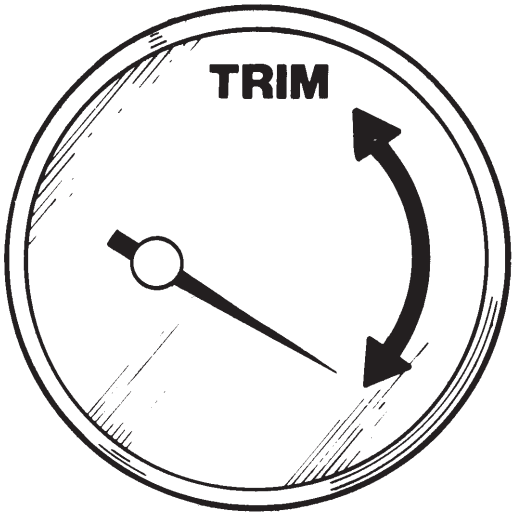
1. Reconnect trim position sender wires to engine harness and trim limit switch leads to trim pump harness.
2. Reinstall battery cables.



22031

a - Positive Battery Lead (+)
b - Negative Battery Lead (–)

3. Turn ignition key to the “RUN” position. DO NOT START ENGINE with the drive unit in the DOWN/IN position. Rotate sender until needle is at bottom mark on the gauge. Retighten screws when adjustment is correct.



22175

Trim Limit Switch Adjustment

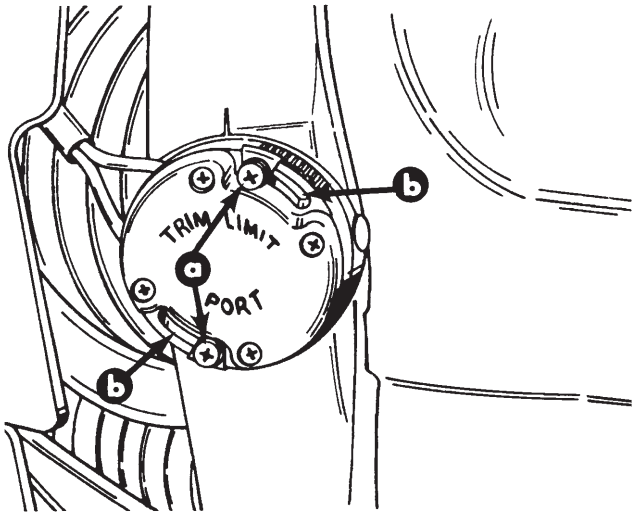
⚠WARNING

When adjusting trim limit switch, use extreme care that engine is not started and keep clear of area near propeller. Use care to prevent placing hands in an area where injury could occur because of drive unit movement.

⚠CAUTION

Trim limit switch MUST BE adjusted exactly as outlined. If switch is adjusted incorrectly, drive unit could move out beyond the gimbal ring support flanges and cause damage to sterndrive unit.

1. Adjust trim limit switch as follows:
   a. Loosen screws and turn trim limit switch clockwise to end of slots.

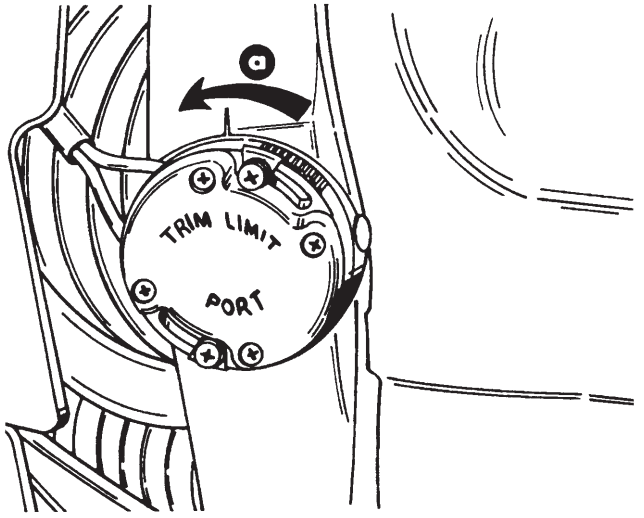


71221

a - Screws
b - Slots

   b. Ensure drive unit is in the full DOWN/IN position.
   c. Using the Trim button on the control, trim drive unit UP/OUT. DO NOT USE TRAILER BUTTON.

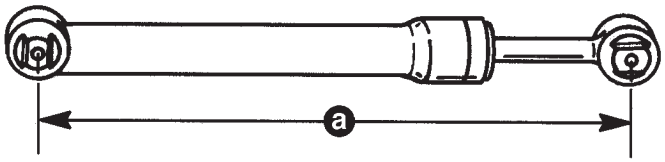
d. Slowly turn trim limit switch counterclockwise until trim cylinders extend to dimension shown (Refer to illustration below.)



71221

a - Rotate Counterclockwise to Adjust

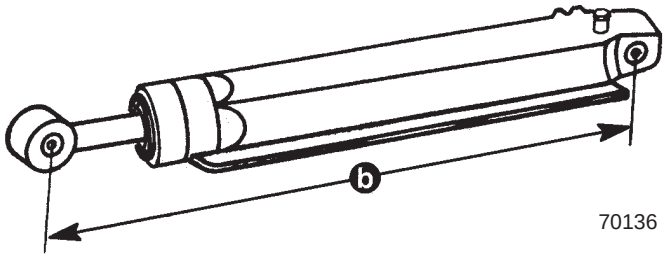
e. Retighten screws when adjustment is correct.



50464

a - 21-3/4 in. Max. (554mm)

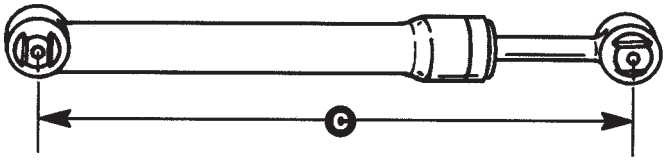
Figure 1. Earlier R/MR/Alpha One Models



70136

b - 20-3/4 in. Max. (520mm)

Figure 2. Alpha One Generation II Models



50464

c - 21-3/4 in. Max. (554mm)

Figure 3. Bravo Models

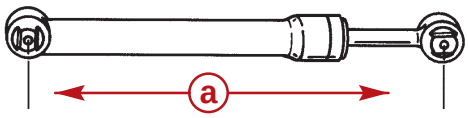
High Performance Transom Assembly - Without Electrical Trim Sender and Trim Limit Switch

IMPORTANT: The electrical Trim Limit Switch and Trim Position Sender are not present on this transom assembly. Without a Trim Limit Switch, the drive unit can be trimmed up/out beyond the position where the drive unit has side support from the gimbal ring at any throttle setting. It is highly recommended that a mechanical (cable actuated) Trim Position Indicator be installed to provide important drive unit trim angle information to the operator and that the Trim Indicator be marked to clearly indicate the maximum up/out position where side support is still provided. The drive unit should not be trimmed to a position beyond gimbal ring side support at engine speeds above 1200 RPM.

⚠ WARNING

Avoid personal injury or damage to sterndrive unit. Do not trim drive unit to an up/out position where the drive unit receives no side support from the gimbal ring at engine speeds above 1200 RPM. Refer to a properly marked mechanical Trim Position Indicator.

1. Install “WARNING DECAL” (Contained in the transom assembly box) at the operator station in a place where it will be clearly visible to the operator.
2. To mark the maximum “Trim Up/Out” position on the mechanical trim indicator, proceed as follows:
   a. Trim drive unit(s) to the “Full Down/In” position.
   b. Check to ensure that the mechanical trim indicator indicates “Full Down/In” position. Adjust the indicator following the manufacturers recommendations.
   c. Slowly raise the drive unit(s) until the trim limit point is reached. The trim limit point can be determined by measuring the amount of trim cylinder extension. The dimension for the Bravo and Blackhawk drive units is **21-3/4 in. (552 mm)**, which is measured from front anchor point to rear anchor point centerlines as shown following.



50464

a - Trim Limit Dimension 21-3/4 in. (554mm)

   d. With the trim cylinders at this position, place a mark on the mechanical trim indicator.
   e. Raise and lower drive unit(s) several times to ensure that the trim limit point is properly marked.

NOTES:

MERCRUISER ELECTRICAL SYSTEMS – LEVEL I

2

G

QUICKSILVER DMT 2000A (and DMT 2004) DIGITAL TACHOMETER/MULTI-METER INFORMATION

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QUICKSILVER
Marine Parts & Accessories

Attention Dealers!

You know from your own marine service experience that outboard ignition systems are very noisy with lots of RFI interference. Our new DMT 2000A Digital Tachometer/Multi-meter represents real breakthrough technology in the marine service industry. It's the only meter on the marine market today designed to read accurately in high RFI environments. The only meter that measures RPM on both 2- and 4-cycle marine engines while recording maximums and minimums simultaneously!

Give your service personnel the latest in innovative marine technology, the DMT 2000A Digital Tachometer/Multi-meter, from Mercury Marine. Order today!

Complete the order form below and we guarantee that your marine service life will get just a little easier!

DESCRIPTION	PART NUMBER
DMT 2000A Complete Kit	**91-854009A 3**
Replacement Components:	
8 ft. (2.4m) inductive pick-up	91-854010 1
Temperature probe	91-854011 1
Replacement ferrite core	91-854012
Interface module	91-854013 1
Hard carrying case	91-854014 1
User's guide	91-854015 1
Test Leads	91-802651
Optional Accessories:	
8 ft. (2.4m) inductive pick-up extension	**84-854016 T**
Clamp-on Current Probe	**91-802650 1**
Direct Voltage Adaptor	**91-89045 1**

DMT 2004 Complete Kit:
P/N 91-892647A01

DMT 2004 similar to DMT 2000A. It has a serial port for connecting meter to a CDS unit.

Order on MIDAS or contact Quicksilver Sales at:

In USA: Phone (920) 929-5589 Fax (800) 457-8736

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Mercury DMT 2000A FAQ'S

- **Q.** What battery does the DMT 2000A take and where is it located?
  A. The DMM requires a 9 volt alkaline battery and is located inside the meter at the bottom of the case inside.

- **Q.** The DMT 2000A keeps using up batteries.
  A. The instrument has a "sleep mode" and not auto power off. Since you may do long term recording there is still a battery draw on the system and it will go dead. This is a normal condition and must be turned off manually each time.

- **Q.** What sizes are the fuses and what are the part numbers?
  A. There are 2 fuses. The small fuse is a 2 amp (MT586-2) and the large fuse is a 10 amp (MT586-3).

- **Q.** The display starts loosing segments and has unusual figures in cold weather, what could be wrong?
  A. Check your operating temperature. It's common for an LCD to freeze below 32 degrees F.

- **Q.** The meter reads "Ouch" is it broken?
  A. No. On Ohms the meter will reach Ouch to signify infinite Ohms. On the temperature selection it means the thermocouple is not inserted or has an open circuit on the thermocouple. Also when in the manual ranging mode the meter will read "Ouch" to indicate the range needs to be increased.

- **Q.** The temperature reads "Ouch" and I just replaced the thermocouple, is there a field fix?
  A. Yes. Since the temperature and mA range share the 2 amp fuse, check for this fuse failure. Also check for thermocouple continuity.

- **Q.** What is the location of the fuses?
  A. The rubber boot should be removed and the 3 screws taken off the back cover. Next "split" the case and remove the back cover. Gently pry the circuit board out of the front case. As you are looking at the circuit board (selector facing you) the 10 amp fuse is on the left side and the 2 amp is on the right.

- **Q.** Can you check the fuses without taking the case apart?
  A. Yes. To check the 10 amp fuse, turn the selector to the "temperature setting" and use one test lead to bridge the common and temperature terminals. The display should read close to room temperature. To check the 2 amp fuse, set the selector to the "diode" setting and bridge the common and Ohms terminals. The display should read very close to zero Ohms if the 2 amp fuse is good.

- **Q.** Does the DMT 2000A have Auto Power Off and Auto ranging?
  A. Yes. The meter will shut off after approximately 30 minutes (this is only a sleep mode, there is still a power draw). It is automatically in auto ranging. The manual ranges can be selected using the "Range" button otherwise it is always in auto ranging.

- **Q.** While using the Inductive RPM mode on small engines the display "hunts" or reads higher than actual RPM, or even locks up the display. What can be done?
  A. Use the RPM 1 signal conditioning module.

- **Q.** Using the RPM mode the RPM's seem to be doubled, why?
  A. On some late model ignition systems, with a "waste spark" system, the plug fires twice per cycle. Simply switch to "2 Stroke" to obtain the correct readings.

- **Q.** While using the Ohms range the display is not stable.
  A. Make sure the test leads are tight in the meter. Also clean the probe ends with a mild abrasive for best contact.

- **Q.** With the test leads touched together the display reads 0.3 Ohms.
  A. This is the actual value of the test lead resistance. To zero the display, for accurate low Ohms, touch the leads together and depress the "Rel" button to zero.

- **Q.** On the Inductive RPM function how do I set the number of cylinders?
  A. It is not necessary when using this technique to measure RPM.

QUICKSILVER®
MARINE PARTS AND ACCESSORIES

91-854009A 3
DMT2000A Digital Tachometer/Multi-Meter Kit

*Instructions similar for a DMT 2004 version.

DMT 2004 Complete Kit:
P/N 91-892647A01

DMT 2004 similar to DMT 2000A. It has a serial port for connecting meter to a CDS unit.



Meter Connections and Hook-up

Interface Module Battery Check

IMPORTANT: The internal battery for the Interface Module (P/N 91-854013-1) MUST BE in good working condition to obtain stable tachometer readings. A low battery voltage will give erratic readings.

PROCEDURE:

1. Plug interface module into **DMT2000A** meter. Refer to **Figure 1-1**. Red lead plugs into the **VΩHz** port and the Black lead into the **COM** port.
2. Position rotary function selector to DC Voltage $\overline{\overline{\mathbf{V}}}$ position. (DMT 2004 - VHz)
3. Reading should be 2.8 Volts or higher.
4. Replace interface module battery if reading is below 2.8 Volts.



Figure 1-1: DMT2000A and Interface Module

Tachometer - Secondary Inductive Pick-Up

IMPORTANT: Use the "2STR" range for tachometer testing on the Mercury/Mariner 4-Stroke Outboards. Refer to DMT2000A information in this User's Manual for additional information and instructions.

PROCEDURE:

1. Plug interface module into **DMT2000A** meter, refer to **Figure 1-2.** Red lead plugs into the **VΩHz** port and the Black lead into the **COM** port.
2. Plug Inductive Clamp (P/N 91-854010), into interface module with lead marked "+" to Red port and lead marked "–" to Black port.
3. Position rotary function knob to IP (RPM Inductive).
4. Depress "RANGE" button to select "2STR" or "4STR" **See important above**.
5. Clip Inductive Clamp to high tension spark plug lead.
6. Read RPM on **DMT2000A** Display.



Figure 1-2: DMT2000A With Filter and Inductive Clamp

Direct Voltage Adapter (DVA) - Optional Accessory (P/N 91-89045)

PROCEDURE:

1. Plug Direct Voltage Adapter into **DMT2000A** meter, refer to **Figure 1-3.** Red lead plugs into the **VΩHz** port and the Black lead into the **COM** port.
2. Plug Test Leads into Voltage Adapter with Red lead into Red receptacle and Black into Black receptacle.
3. Position rotary function knob to DC Voltage scale, indicated by $\overline{\overline{V}}$. (DMT 2004 - VHz)
4. Read DC Voltage on **DMT2000A** Display.



Figure 1-3: DMT2000A with Direct Voltage Adapter and Test Leads

Attaching Alligator Clips

PROCEDURE:

1. Screw alligator clips over ends of probes with Red to Red and Black to Black. Refer to **Figure 1-4 Attaching Alligator Clips.**
2. Tighten alligator clips finger tight.



Figure 1-4: Attaching Alligator Clips

Temperature Probe

PROCEDURE:

1. Plug small Thermocouple Plug into Thermocouple Probe with “–” to “–” and “+” to “+”, refer to **Figure 1-5.**
2. Plug Thermocouple Probe into **DMT2000A** with “+” side to **VΩHz** port, refer to **Figure 1-6.**
3. Position rotary function knob to **TEMP** position. Use FUNCTION key to toggle between °C and °F.
4. Read temperature on **DMT2000A** Display.



Figure 1-5: Thermocouple Plug



Figure 1-6: Thermocouple to Meter

Clamp-On Current Probe - Optional Accessory (P/N 91-802650)

IMPORTANT: Refer to Users Guide supplied with Clamp-On Current Probe for proper testing procedures.

PROCEDURE:

1. Plug end of Clamp-On Probe with side marked "+" into **VΩHz** port and side with "–" to **COM** port, refer to **Figure 1-7 and Figure 1-8:** Clamp-On Probe to Meter.
2. Position rotary function knob to DC Voltage scale, indicated $\overline{\overline{V}}$. (DMT 2004 - mV)
3. Read DC Voltage on **DMT2000A** Display.

   (1 mV = 1 amp)



Figure 1-7: Clamp-On Probe



Figure 1-8: DMT2000A with Clamp-On Current Probe

NOTES:

FUEL SYSTEMS – LEVEL I

3
A

FUEL DELIVERY SYSTEM AND CARBURETION

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Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine seriously. Engine damage resulting from use of improper gasoline is considered misuse of engine, and damage caused thereby will not be covered under the limited warranty.

FUEL RATINGS

USA and Canada - MerCruiser engines (with the exception of the early Black Scorpions [specified below]) in the USA and Canada will operate satisfactorily when using a major brand of unleaded gasoline having a MINIMUM pump posted Octane Rating of 87 AKI (anti knock index), which is the average of the RON (research octane number) and the MON (motor octane number).

Federal regulations mandate that you DO NOT use leaded gasoline in the USA and Canada.

Higher octane fuels can be used on all models with the exception of early EFI models. On early EFI models refer to Service Bulletin 94-12. If these engines are equipped with the original ECM, 87 AKI fuel must be used and higher octane fuels must NOT be used.

Early Black Scorpions – Black Scorpions with serial number 0L0058999 and below must use fuel with a 91 AKI minimum. Black Scorpions with serial number 0L0059000 and above can use fuel with a 87 AKI minimum.

Outside USA and Canada - MerCruiser engines (with the exception of the early Black Scorpions [specified below]) outside the USA and Canada will operate satisfactorily when using a major brand of unleaded gasoline having a MINIMUM research octane number (RON) of 90. The use of leaded gasoline is acceptable unless prohibited by government regulations.

Higher octane fuels can be used on all models with the exception of early EFI models. On early EFI models refer to Service Bulletin 94-12. If these engines are equipped with the original ECM, 90 RON fuel must be used and higher octane fuels must NOT be used.

Early Black Scorpions – Black Scorpions with serial number 0L0058999 and below must use fuel with a 98 RON minimum. Black Scorpions with serial number 0L0059000 and above can use fuel with a 90 RON minimum.

USING REFORMULATED (OXYGENATED) GASOLINES (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of “oxygenates” used in these fuels is Alcohol (Ethanol) or Ether (MTBE or ETBE). If Ethanol is the “oxygenate” that is used in the gasoline in your area, refer to “Gasolines Containing Alcohol.”

These “Reformulated Gasolines” are acceptable for use in your MerCruiser engine.

GASOLINES CONTAINING ALCOHOL

If the gasoline in your area contains either “methanol” (methyl alcohol) or “ethanol” (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with “methanol.” Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat’s fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boats fuel system components (fuel tanks, fuel lines, and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts.
- Deterioration of rubber or plastic parts.
- Fuel permeation through rubber fuel lines.
- Starting and operating difficulties.

⚠ WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic metal or fiberglass, fuel lines, fittings, fuel filters and carburetors/fuel injection components should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Test For Alcohol Content In Gasoline

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

Procedure

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes.** If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

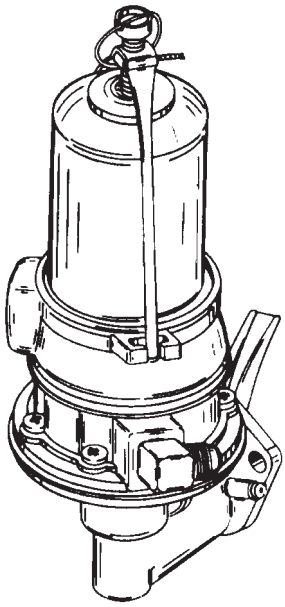
WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

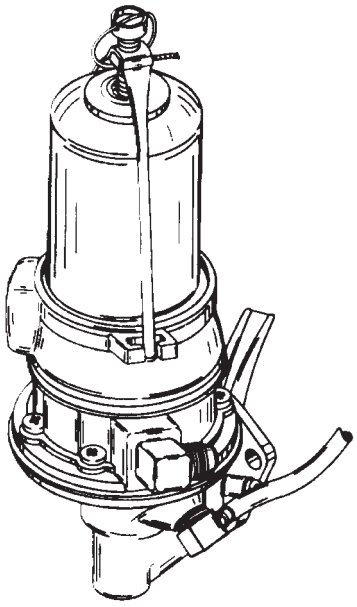
WARRANTY

Performance problems and fuel system or other damage resulting from the use of gasoline-alcohol blended fuels are not the responsibility of MerCruiser and will not be covered under our warranty.

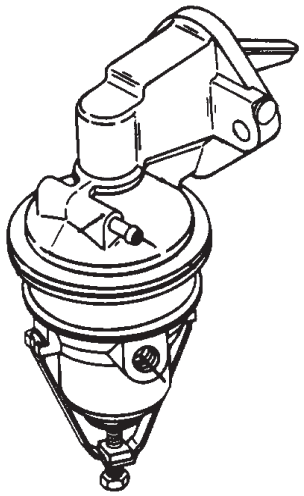
Fuel Pump Identification, and Test Fitting



**CARTER (LOW VOLUME)
NON-SIGHT TUBE TYPE**

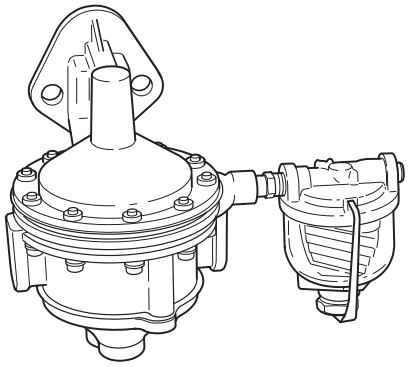


**CARTER (LOW VOLUME)
SIGHT TUBE TYPE**



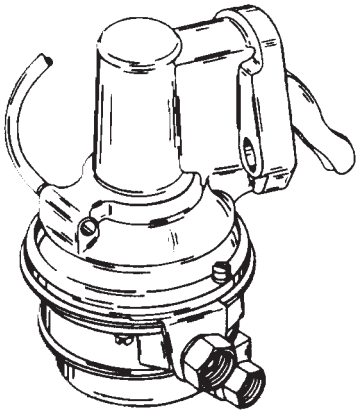
76036

CARTER (HIGH VOLUME)

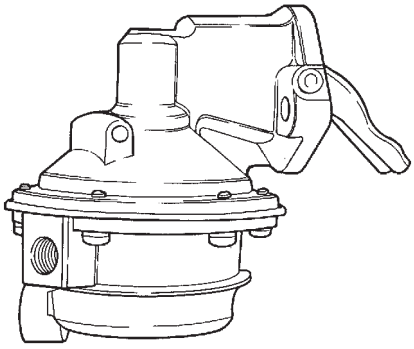


AC (DUAL DIAPHRAGM)

a - Sight Glass

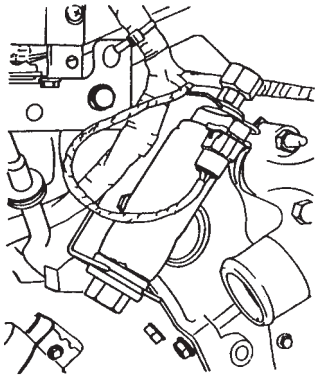


**AIRTEX
(SINGLE DIAPHRAGM)**



72677

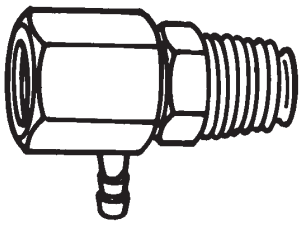
CARTER



**4.3L (262 CID) GM V-6 Gen II
ELECTRIC FUEL PUMP**

**IN-LINE CONNECTOR
(P/N 91-18078) FOR CHECKING
FUEL PUMP PRESSURE**

A service tool is available for MerCruiser engines allowing connection of a fuel pressure gauge to check fuel pump pressure. The tool connects between the fuel pump and carburetor. Caution must be taken that all fuel lines and fittings are tightened securely.



73469

Fuel Delivery System

⚠ WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when constructing the engine compartment.

GENERAL

The main concern of a boat's fuel system is safety; this must be achieved through a technically sound installation and constant inspection.

The fuel system, from the filler pipe to the fuel pump, is the same in principle for all boats.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank manufacturer.

Only a few points related to function and safety are listed here [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

- All connections should be on the upper side of the tank.
- The drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The filler pipe outer diameter should be at least 2 in. (50 mm).
- The tank breather pipe must have an inner diameter of at least 1/2 in. (13 mm) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

1. **On Gasoline Engines:** Fuel tank should be mounted below carburetor level (if possible) or gravity feed may cause carburetor fuel inlet needle to unseat and flooding may result.
2. Fuel pickup should be at least 1 in. (25 mm) from the bottom of fuel tank to prevent picking up impurities.
3. **On Gasoline Engines:** The maximum measured vacuum at the engine's fuel inlet must not exceed 2 in. Hg or 1 psi (6.9 kPa) at 600, 3000, full throttle rpm, and idle rpm.

IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance because of fuel starvation.

4. **On Gasoline Engines:** Fuel lines used must be Coast Guard approved (USCG Type A1).

Diameter of fittings and lines must not be smaller than 5/16 in. (8 mm) ID on 262 CID/4.3L and 305 CID/5.0L and 350 CID/5.7L engines.

Diameter of fittings and lines must not be smaller than 3/8 in. (10 mm) I.D. on 377 CID/6.2L, 454 CID/7.4L and 502 CID/8.2L engines.

5. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.

6. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
7. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
8. Sharp bends in fuel lines should be avoided.
9. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

SPECIAL INFORMATION ABOUT ELECTRIC FUEL PUMPS

⚠ CAUTION

The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

SPECIAL INFORMATION FOR ALL GASOLINE ENGINES

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. NEVER use gasoline as a cleaning solvent.

IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:

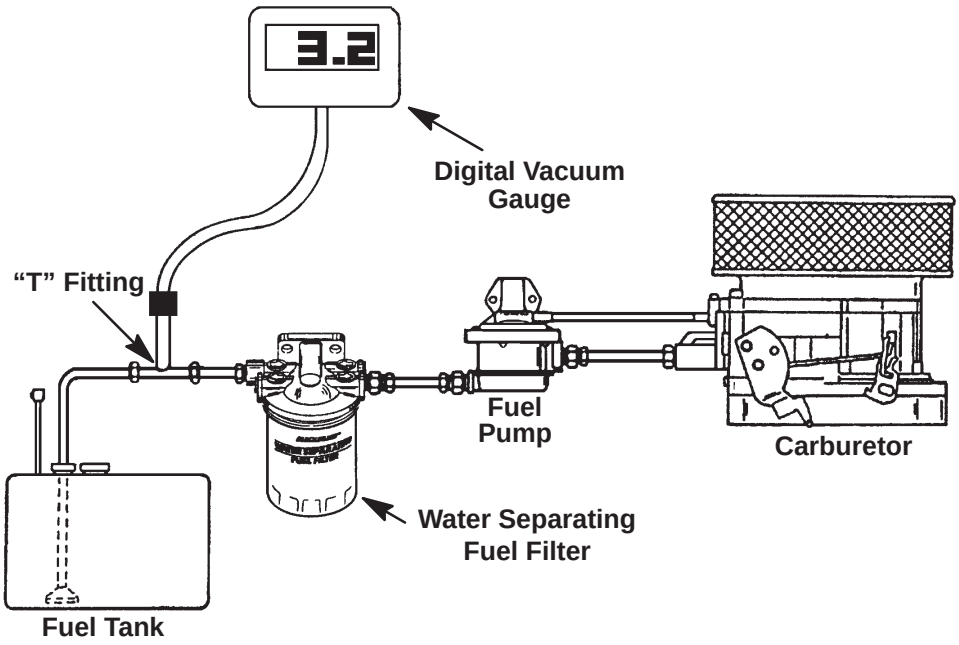
- **Use #592 Loctite Pipe Sealant with Teflon on threads of brass fittings or plugs. DO NOT USE TEFLON TAPE.**
- **Brass fittings or plugs should first be threaded into fuel pump or fuel filter base until finger tight.**
- **Fittings or plugs should then be tighten an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **To prevent over-tightening when installing a fuel line, the brass fittings should be held with a suitable wrench as fuel line connectors are tightened securely.**

Checking for Restrictions in Fuel Delivery Systems

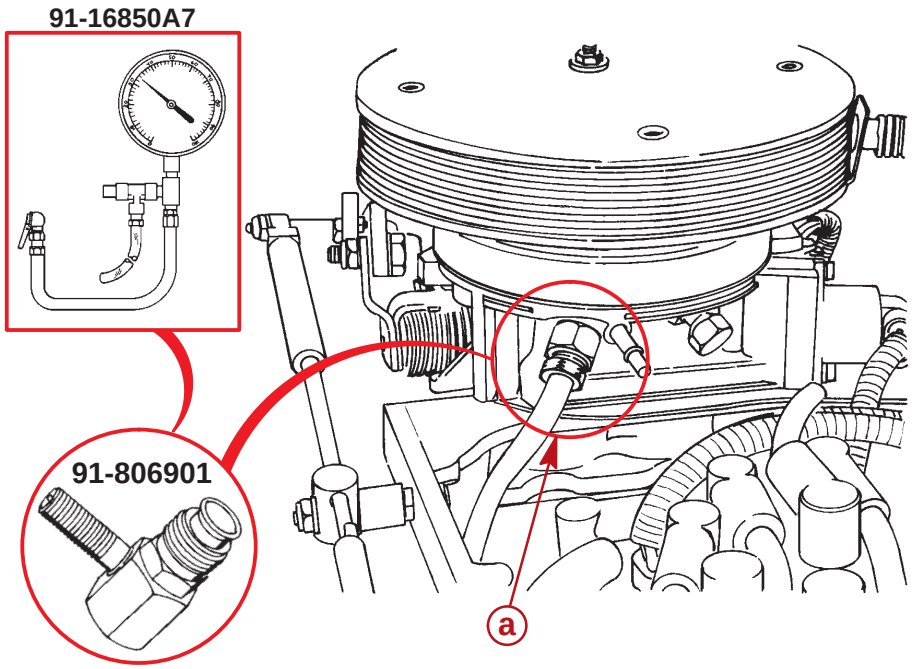
If there are any restrictions in the fuel delivery system the engine may experience vapor lock and other driveability problems. MerCruiser specifies that the **maximum allowable vacuum** (when measured at the inlet side of the engine mounted, water separating fuel filter) is **2 in. Hg.** (inches of mercury), or **6.9 kPa** (kilopascals).

The engine should be tested by installing a “T” fitting and gauge, as shown in the illustration. A digital vacuum gauge is recommended because regular vacuum gauges are, for the most part, inaccurate at these low readings. The engine should be run at idle, 3,000 rpm, WOT and back at idle rpm. Gauge readings should not exceed the maximum allowable vacuum specification at any of these throttle settings.

Restrictions in the delivery system can be caused by sticky anti-siphon valves, too small a diameter of fuel lines and fittings, extra fuel fittings (90°), additional fuel filters, clogged filters, plugged fuel tank pick-ups, etc. See MerCruiser Service Bulletin 99-7.



Testing Fuel System Pressure on EFI Throttle Body Injection Systems



a - Remove Fuel Line from Throttle Body Unit and Install Fuel Fitting Connector P/N 91-806901. Connect Fuel Pressure Gauge Kit, P/N 91-16850A7, to test system pressure.

V-6 and Small Block V-8 Electric Fuel Pump Used on Carbureted Models

For engine starting and running the electric fuel pump uses two electric circuits. These two circuits are designed to prevent the fuel pump from running if the key is accidently left on.

A jumper wire connects one side of the oil pressure switch to the electrical harness. The purple wires in the harness are supplied current when the key switch is in the run position. When the engine is running, oil pressure (4 psi) holds the contacts inside the oil pressure switch closed. Current will pass through the closed contacts and on to the purple/yellow wire, connecting to the fuel pump.

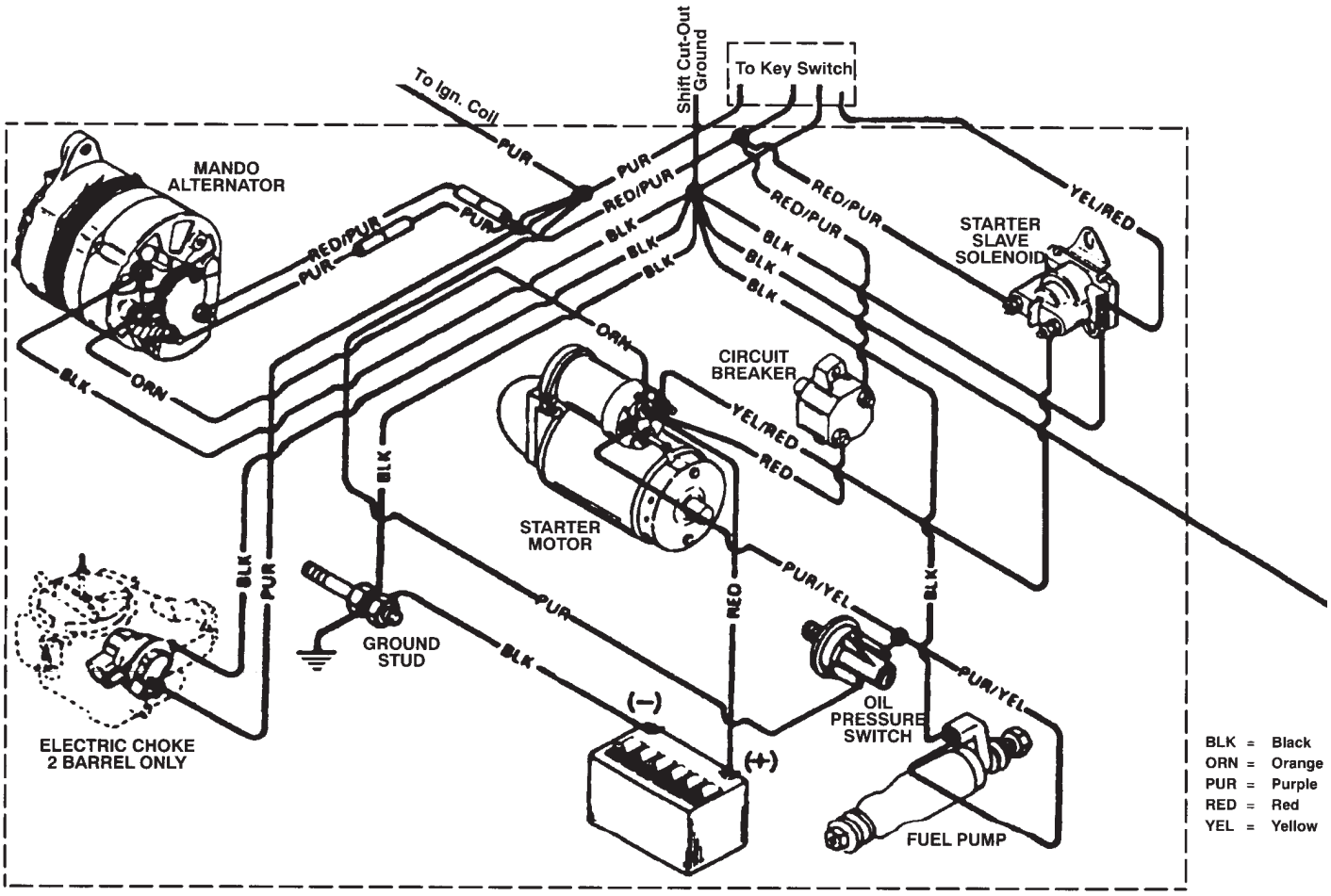
During starting; the oil pressure switch is open due to little or no oil pressure. To engage the starter, the starter solenoid is activated by current through the yellow/red wire. With the solenoid activated, a metal disk inside the solenoid connects the positive battery terminal to the purple/yellow wire. This connection bypasses the oil pressure switch and supplies current to the fuel pump.

Fuel Pressure 3 - 9 psi

Electric Fuel Pump RFI Filter Replacement S/B 92-15

Sticking Fuel Pump Check Valves S/B 98-4

Gasoline Additive Problems S/B 98-5



MerCruiser Carburetor Adjustments

1. **Float level** – affects air/fuel ratios at all engine speeds and loads.
2. **Float drop** – ensures maximum fuel flow into the float chamber, yet prevents needle falling out of inlet seat.
3. **Initial idle mixture** – provides a base starting point for idle mixture.
4. **Accelerator pump adjustments:**
   a. **Linkage position in accelerator pump arm** – determines volume of fuel to be delivered per stroke.
   b. **Pump rod measurement** – ensures maximum fuel delivery for the linkage position selected.
5. **Choke unloader** – determines choke plate opening at W.O.T. on a COLD engine.
6. **Choke pull-off (vacuum break)** – sets choke plate opening immediately after startup on a COLD engine.
   a. Not used on MerCarb.
7. **Choke spring (electric choke, divorced choke or stove-pipe)** – Determines the total time duration of choke operation.
8. **Final idle mixture and idle speed** – prevents stalling at low speeds & shifting problems.
   a. Engine must be at normal operating temperature.
   b. Boat must be in the water with the correct propeller installed.
   c. Outdrive in specified gear (check service manual).
   d. On Thunderbolt 5 ignition systems, the purple/white timing lead must be connected to ground before starting the engine. This locks out the ignition's idle speed timing control.

Recommended fuel system literature:

"Changes in Gasoline"
1996 Manual and 2000 supplement
@ 1-800-378-9974,
Fax @ 1-219-546-5845.
96 Manual is $2.50, supplement is $1.50,
both for $3.50.

Recommended Training Videos:

MerCruiser Carburetion
8 Point Checklist (90-823732-57) MU-V55

MerCruiser Vapor Lock:
Theory and Prevention (90-823732-80) MU-V78

Anti-siphon Valves:

EVM, Inc.
1009 Madison Street
P.O. Box 153
Two Rivers, WI 54521
800-457-2490 (voice)
920-793-1406 (fax)
(Large sizes available)

Applicable Fuel System Service Bulletins:

SB 97-8	MerCarb Adjustments & troubleshooting
SB 97-9	Weber Adjustments & troubleshooting
SB 97-17	Carbureted engines "dieseling"
SB 98-4	Electric fuel pump check ball "sticking"
SB 98-5	Fuel detergents causing "sticking" problems
SB 99-7	Troubleshooting Vapor Lock problems
SB 2000-5	Electric fuel pump recall
PB 98-6	**Parts Bulletin** on replacement fuel system parts

MerCarb - Two Barrel, MerCruiser Carburetor

Identification

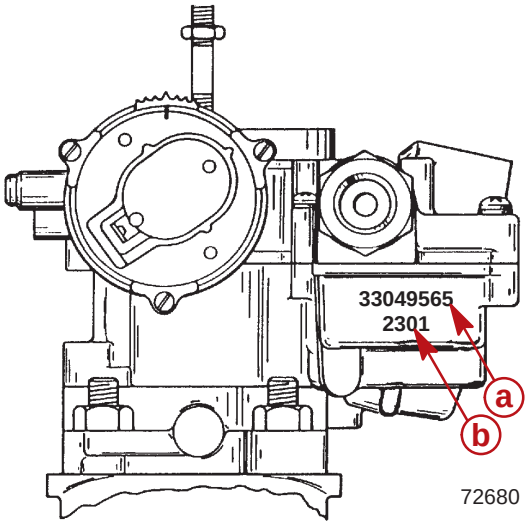


Figure 1. Carburetor Part Number Location

a - Part Number
b - Date Code

An embossed tag stamped with the MerCarb Part Number also is attached to one of the air horn attaching screws. (Figure 2)

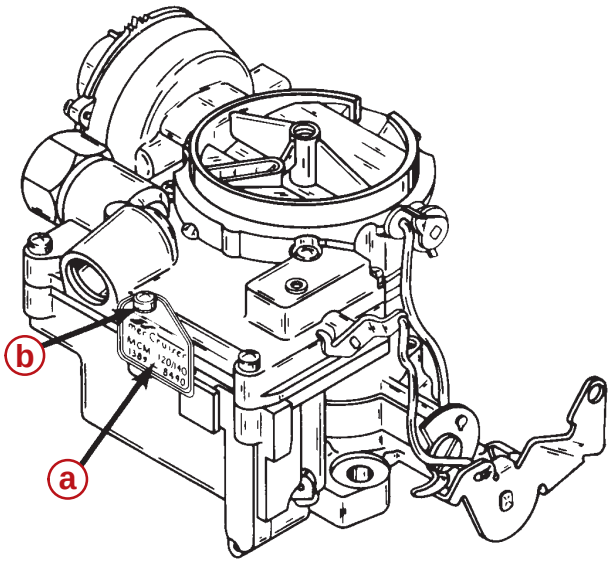
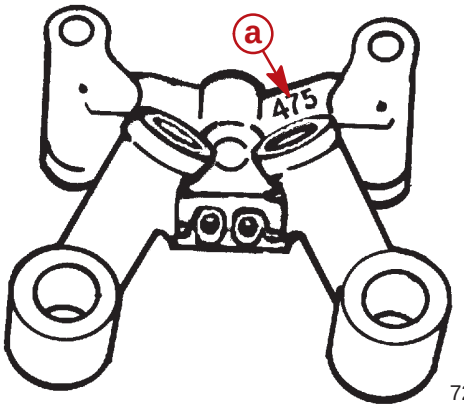


Figure 2. Part Number Tag Location

a - Part Number (Embossed Tag)
b - Air Horn Attaching Screw

Data Code Explanation: Example 2301

First Figure is Year:
2 = 1992, 3 = 1993, etc.
Second Figure is Month:
2 = February, 3 = March, etc.
X = October, Y = November, Z = December
Third and Fourth Figures are Day of Month:
01 = First day, 02 = Second day, etc.



72779

Venturi Cluster Identification

a - Identification Number (See Specifications)

NOTE: *The MerCarb carburetor will not backfit MerCruiser 120/140 engines which utilize the Rochester 2GC carburetor.*

The MerCarb may be distinguished from the Rochester 2GV carburetor, as follows:

MerCarb – Single Idle Mixture Needle

Rochester 2GV – Two Idle Mixture Needles

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel/air mixture to the engine.

MerCarb Repair Kit Part Numbers

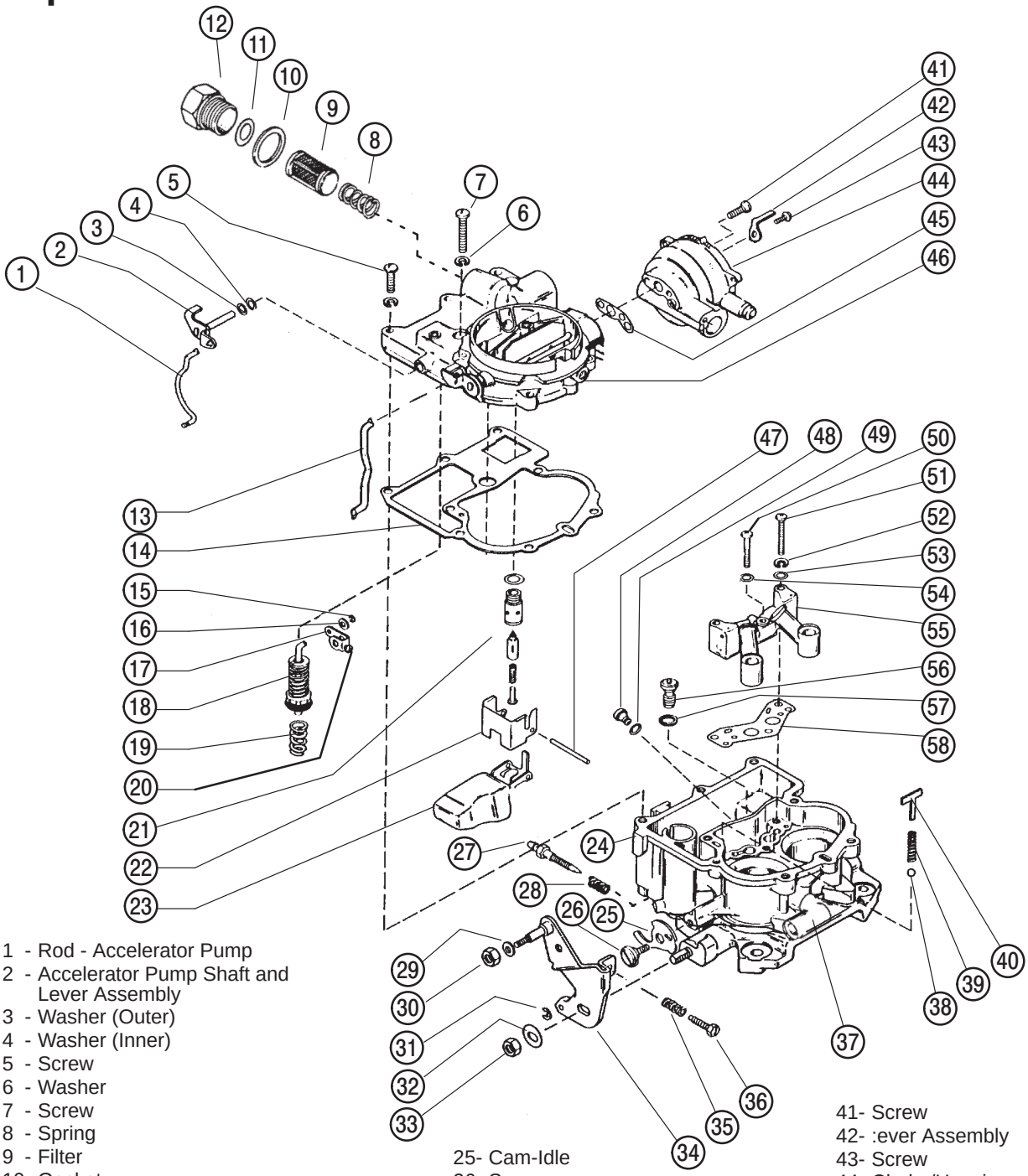
The following part numbers are difficult to locate but can be found in the 2003 Parts Guide.

MerCarb (with large accelerator pump) repair kit 3302-804844

MerCarb (with small accelerator pump) repair kit 3302-804845

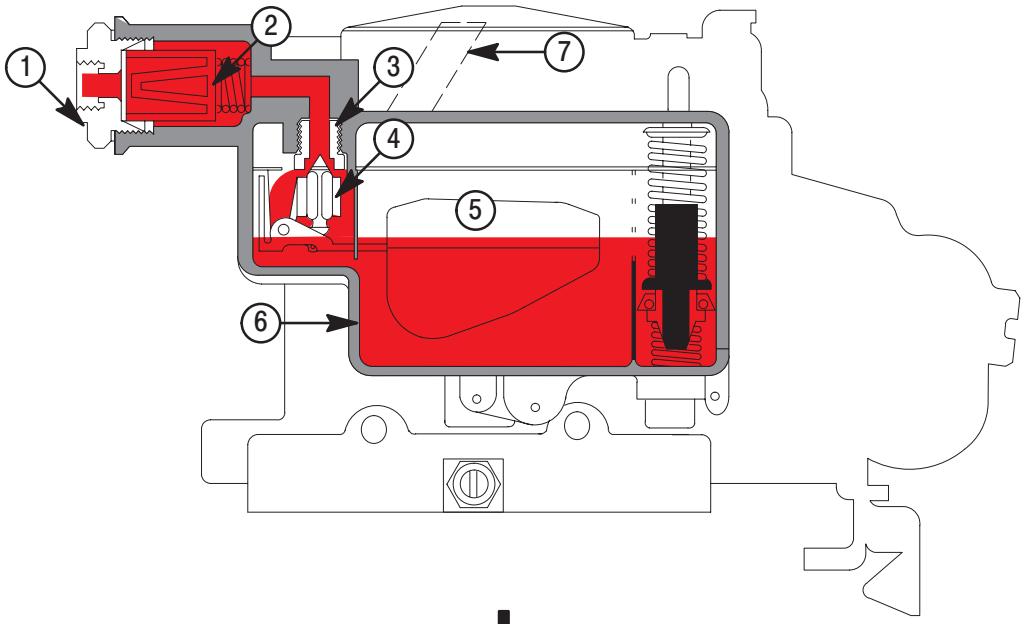
These kits do not contain the power valve or float which may be ordered with MIDAS/MercNet.

MerCarb - Two Barrel, MerCruiser Carburetor - Exploded Parts View



1 - Rod - Accelerator Pump
2 - Accelerator Pump Shaft and Lever Assembly
3 - Washer (Outer)
4 - Washer (Inner)
5 - Screw
6 - Washer
7 - Screw
8 - Spring
9 - Filter
10- Gasket
11- Gasket
12- Nut-Fuel Inlet
13- Choke Rod
14- Gasket
15- Clip - Retainer
16- Washer
17- Pump Shaft and Lever Assembly
18- Accelerator Pump Assembly
19- Screw
20- Screw
21- Inlet Needle and Seat (Spring Loaded)
22- Baffle Plate
23- Float
24- Carburetor Body
25- Cam-Idle
26- Screw
27- Idle Mixture Adjusting Needle
28- Spring
29- Washer
30- Nut
31- Clip-Pump Rod
32- Washer-Locking
33- Nut
34- Throttle
35- Spring
36- Screw - Idle Speed Adjustment
37- PCV Tube Connection Fitting
38- Check Ball
39- Spring
40- Retainer
41- Screw
42- :ever Assembly
43- Screw
44- Choke/Housing
45- Gasket
46- Air Horn
47- Pin
48- Screw
49- Gasket
50- Screw
51- Screw
52- Lock Washer
53- Flat Washer
54- Gasket
55- Venturi Cluster
56- Power Valve Assembly
57- Gasket
58- Gasket

Fuel Systems – Carburetors
MerCarb



Vacuum and Fuel delivery

Vacuum is the primary principle which is used to deliver fuel into the air stream. The vacuum is a result of the engine drawing air/fuel into the cylinders on the intake stroke. The atmospheric pressure inside the float bowl will force the fuel into the low pressure area which is created by engine vacuum.

Venturi vacuum develops when air passes through a restricted area or venturi at high speed. The air pressure within the venturi drops as the air speed increases. The vacuum which results is exposed to various ports inside the carburetor as the throttle position changes.

Float System

DESCRIPTION

The carburetor float system controls the fuel level in the carburetor bowl. Fuel level is very important because it must be maintained to give proper carburetor metering throughout all ranges of engine operation. If the fuel level is to high in the float bowl, problems such as rich mixtures affecting fuel consumption, fuel spillage from the main discharge nozzles on turns, and engine loading can result. If the fuel level is lower than the specified setting it can cause lean mixtures, hesitation on acceleration, engine surge, plus engine cut-out during heavy fuel demands.

The float system operates as follows:

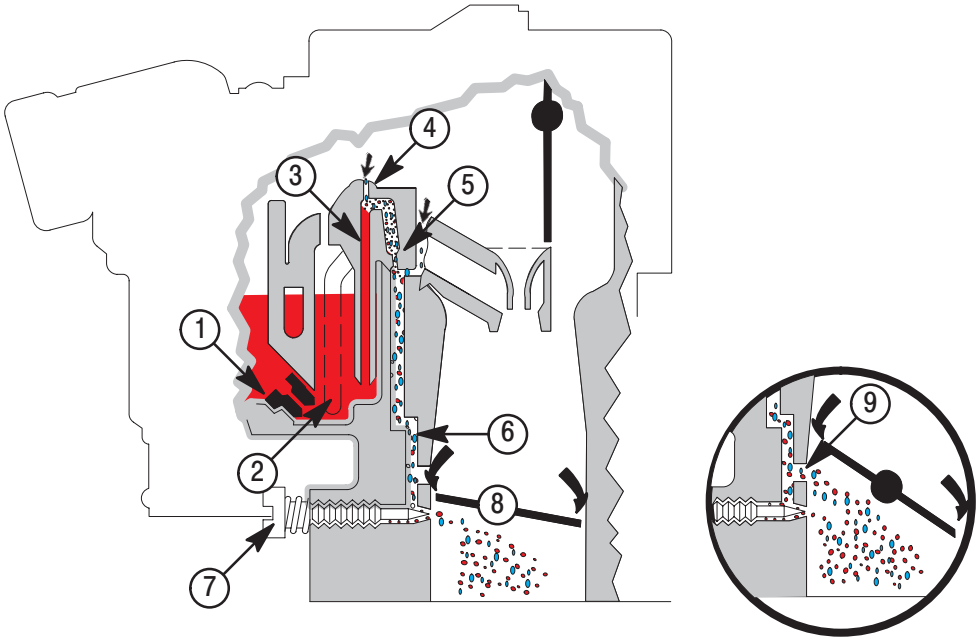
Fuel from the engine fuel pump is forced through the fuel inlet fitting (1), inlet filter (2), and on through the float needle seat (3), past the float needle (4), into the float bowl (6). Fuel flow continues until the fuel raises the float pontoon (5) to a position where it forces the float needle against the needle seat and shuts off fuel flow. As fuel is used from the carburetor bowl, during engine operation, the float again drops downward, moving the float needle off its seat, allowing more fuel to flow into the float bowl, thereby keeping the fuel level constant.

The float drop tang located at the rear of the float arm prevents the float from moving too far downward. The maximum float drop must be maintained so that the float assembly will drop sufficiently to allow maximum fuel flow under heavy engine demands.

An internal fuel filter is located behind the fuel inlet fitting. The filter assembly consists of a spring, filter element, relief spring, and a gasket. The open end of the filter faces the fuel inlet nut. The filter element is spring-loaded to provide a pressure relief so that in the event the filter should clog, the restriction will cause the fuel pump pressure to overcome the filter relief spring pressure and allow fuel to by-pass the filter, to keep the engine running and enable the driver to get a service outlet for repair.

The bowl vent (7) is internal inside the air horn just below the flame arrestor. The amount of fuel metered by the carburetor is dependant upon the pressure inside the float bowl causing the fuel to flow. The vent system assures that any pressure “build-up” in the float chamber during hot engine operation, caused by fuel vapors, will be relieved into the flame arrestor. During normal engine operation when the engine is running, manifold vacuum pulls the fuel vapors into the engine.

MerCarb
Idle System



DESCRIPTION

The MerCarb has an idle system to supply the correct air/fuel mixture ratios to the engine during idle and low speed operation. The idle system is necessary during this period because air flow through the carburetor venturi is not great enough to cause fuel to flow from the main discharge nozzles.

At idle speed the throttle valves (8) are held slightly open by the idle speed screw. The small amount of air which passes between the throttle valves and bores is regulated by the screw to give the desired idle speed.

Since the engine requires very little air for idle and low speed, fuel is added to the air by the application of vacuum (low pressure) from the intake manifold, directly through the idle system to the fuel in the carburetor float bowl. With the idle mixture screw (7) holes located in a high vacuum (low pressure) area below the throttle valves and fuel in the float bowl vented to atmosphere, the idle system operates in the following manner.

Fuel from the float bowl flows through the main metering jets (1) into the main fuel well (2). It is then picked up and metered by the calibrated orifice at the tip of the idle tubes (3). It then passes up the idle tubes and is mixed with air from the air bleeds (4) located on the top of the idle tubes and in the idle cross channels in the venturi cluster casting. The mixture then passes downward in the idle channels (6) through a calibrated restriction (5) to the off-idle discharge slots (9). Here the fuel mixture is again bled with air and then moves to the idle mixture screw holes where it is discharged and blends with the air passing the slightly open throttle valves and enters the intake manifold as a combustible mixture.

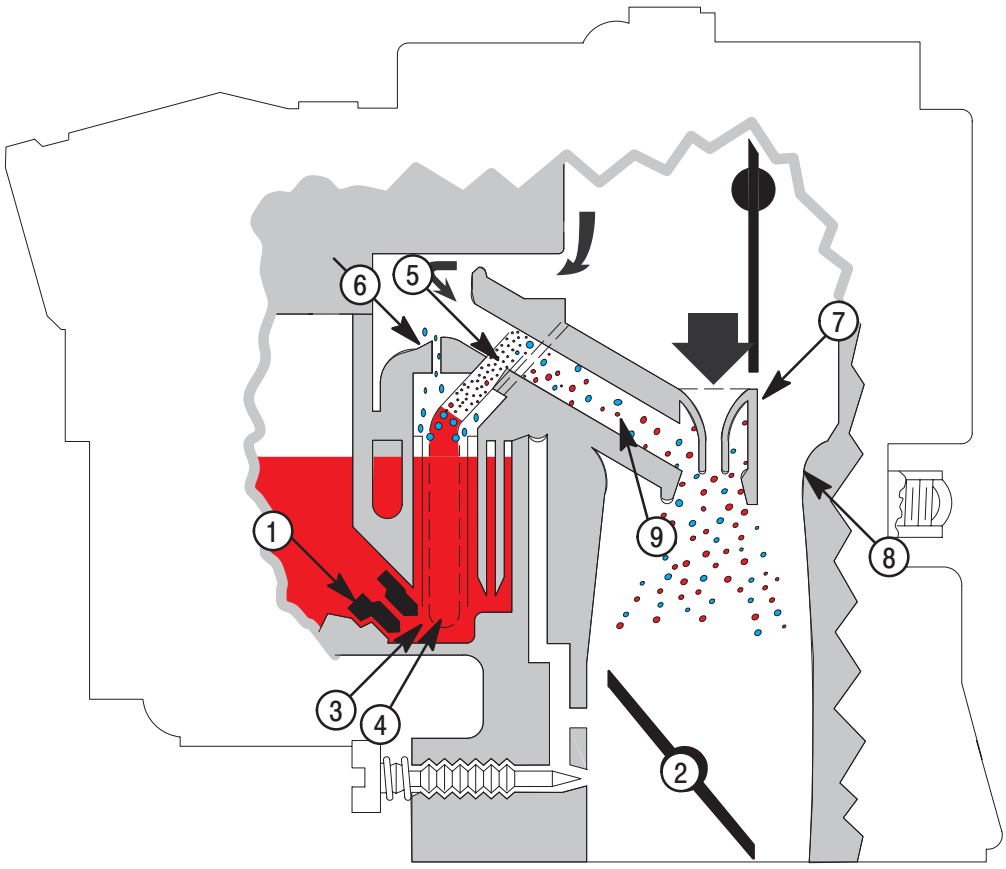
The idle mixture screw controls the amount of fuel mixture which enters each carburetor bore. If the idle mixture screw or needle is backed out, more mixture is admitted to the intake manifold and the engine runs rich. If the screw is turned in, the engine runs lean. In this manner, the idle mixture is varied for best idle. *(**NOTE:** Engines built after Jan. 1, 2003 have sealed idle mixture screws.)*

OFF-IDLE OPERATION

As the throttle valves are opened and more air is entering the engine to increase engine speed, additional fuel is needed to combine with the extra air. This is accomplished by the off-idle discharge slots. As the throttle valves move past the off-idle slots, they become progressively exposed to high vacuum below the throttle valves and the extra fuel needed is supplied by these holes.

The idle holes and off-idle slots supply sufficient fuel for engine requirements until air velocity is high enough in the venturi area to obtain fuel flow from the main metering system.

MerCarb
Main Metering System



DESCRIPTION

The main metering system supplies fuel to the engine from off-idle to wide open throttle. The main metering system provides efficient fuel metering during the cruising range. Its operation is dependant upon air flow through the carburetor venturi (8) which, in turn, creates a low pressure in the venturi area causing fuel to flow.

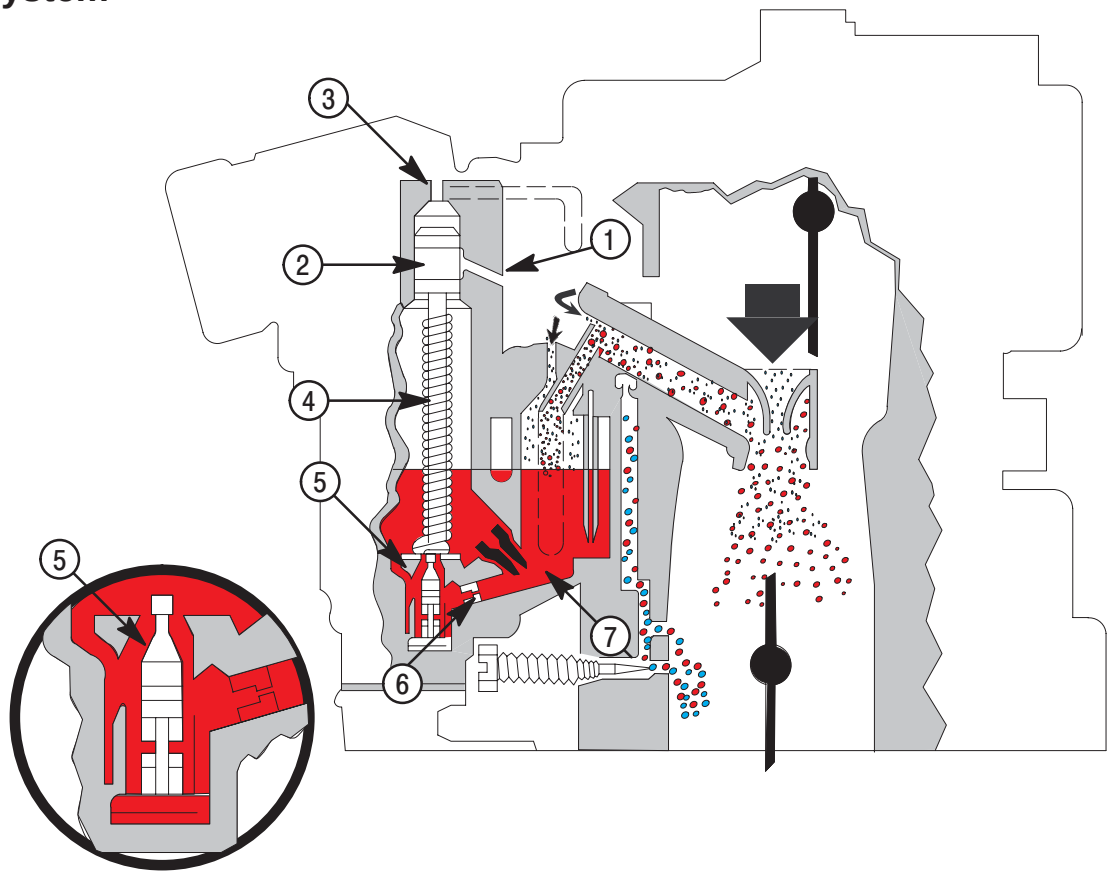
As the throttle valves (2) are opened beyond the off-idle discharge slots, allowing more air to enter the intake manifold and engine speed to increase, the vacuum decreases below the throttle valves and the off-idle gradually diminishes.

With the increased throttle opening, there is an increased air velocity in the venturi system. This causes a drop in pressure in the main venturi which is increased many times in the boost venturi (7), fuel will flow in the following manner.

The low pressure in the boost venturi is transmitted to the tip of the main well tube (9) or main discharge nozzle (5). Atmospheric pressure, which is greater, forces fuel from the float bowl through the main metering jets (1) and into the main well (3). As the fuel passes through the main well tubes (4), it is mixed with air from the calibrated main well bleeds (6). The fuel mixture then passes from the tip of the discharge nozzle, through the mixture passage, to the boost venturi and on into the intake manifold.

As the throttle valve opening is increased, and more fuel is drawn through the main well tubes, the fuel in the main well drops. The calibrated holes in the main well tubes are proportionately exposed to the air in the upper well area. When this occurs, they become air bleeds mixing progressively more air with the fuel passing through the main well tubes. Therefore, although the nozzle suction is increased at higher engine speeds, the air/fuel mixture to the engine remains constant throughout part throttle range.

MerCarb
Power System



DESCRIPTION

The power system in the MerCarb provides extra mixture enrichment to meet power requirements under heavy load and high speed operation. The richer mixtures are supplied through the main metering system. The spring-loaded power piston (2), located in the cavity of the air horn, directly above the power valve (5), is held in the up position by engine manifold vacuum supplied directly through a connecting passage from the base of the carburetor. The power system is exposed to manifold vacuum at all times.

During idle and cruising ranges, the relatively high engine vacuum holds the power piston in the up position against tension of a calibrated spring located on the power piston stem. During this period, the power valve remains closed.

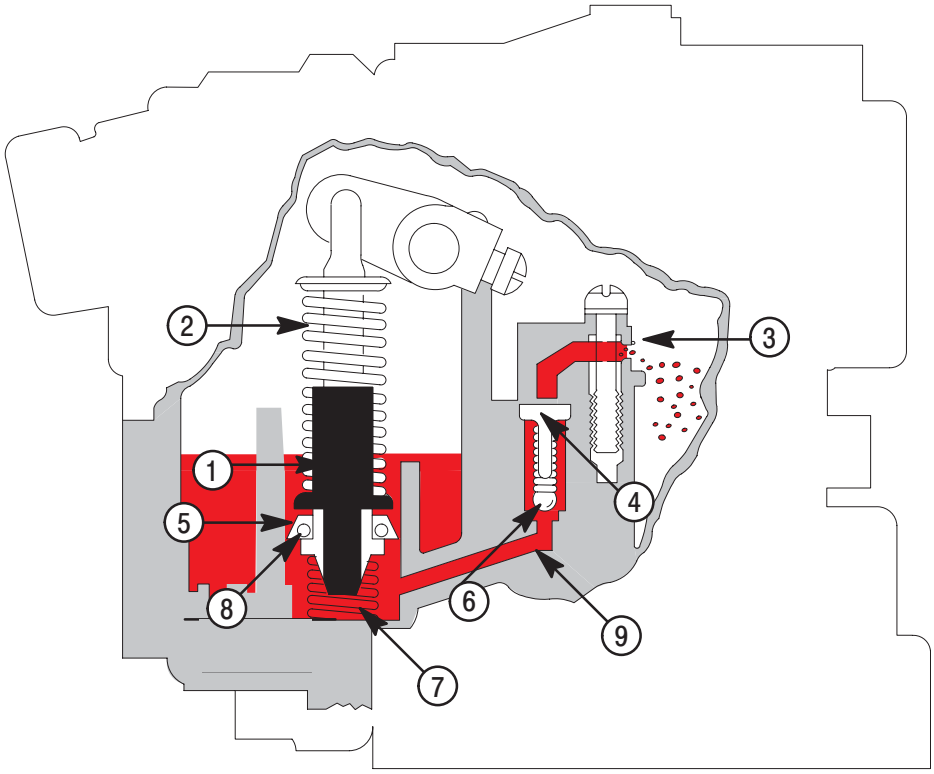
Increases in engine load lower the manifold vacuum. when it has dropped sufficiently, the power piston spring (4) overcomes the upward vacuum pull and the power piston moves downward, opening the power valve to allow additional fuel to flow through the calibrated restrictions (6) and on into the main well area (7). The fuel flowing through the power system supplements the fuel passing through the main metering jets to give the proper mixtures required for power operation.

A hole (1) drilled from the carburetor air horn to the bore of the power piston cavity to break any vacuum that might leak around the sides of the power piston. The purpose of the vacuum break hole is to prevent the transfer of vacuum from the piston to the top of the fuel in the float bowl. Any vacuum acting on the fuel in the float bowl will affect carburetor calibration.

The power valve, installed in the bottom of the float bowl, consists of a plunger and a closing spring. When manifold vacuum drops to a predetermined point (called “power cut-in”) dependant upon engine load and throttle opening, the power piston moves downward under spring tension to force the power valve plunger off its seat. Then, fuel flows through the valve on into separate fuel channels passing through calibrated restrictions, by-passing the main metering jets, and then on into the main well.

MerCarb

Pump System



DESCRIPTION

During quick acceleration when the throttle is opened rapidly, the air flow and manifold vacuum change almost instantaneously, while the heavier fuel tends to lag behind causing a momentary leanness. The accelerator pump is used to provide the fuel necessary for smooth operation during this time.

Fuel for acceleration is supplied by a double spring-loaded pump plunger (1) operated by a pump shaft and lever assembly, in the air horn, connected directly to the throttle lever by a pump rod. The top (2) and bottom (7) springs combine to move the plunger so that a smooth sustained charge of fuel is delivered for acceleration.

When the pump plunger moves upward as happens during throttle closing, fuel enters the slotted pump well, flows around the side of the pump plunger and into the bottom of the pump well.

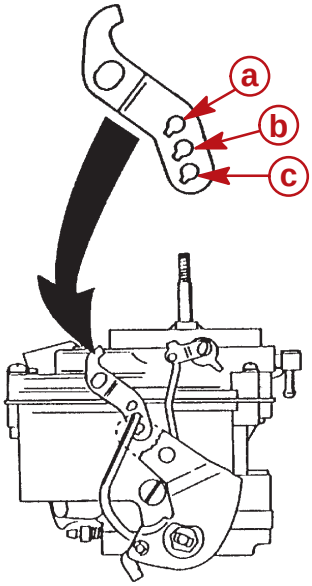
When the throttle valves are opened, the connecting linkage forces the pump plunger downward in the well. The downward motion of the plunger forces fuel into the pump discharge passage (9) and unseats the pump discharge check ball (6). Fuel then passes on through the passage to the pump jets (3) in the cluster where it sprays into the venturi area.

The pump discharge check ball is used in the pump discharge passage to prevent air from being drawn into the passage during upward movement of the pump plunger to prevent a momentary delay in delivery of fuel.

The plunger uses a pump cup expander (Garter) spring (8) to maintain constant pump cup to pump wall contact.

Adjustable Accelerator Pump Lever

This new 3-holed lever will allow you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole farthest away will give about 1.0 cc less fuel.



73131

a - Full Accelerator Pump Stroke
b - 0.5 cc Less Fuel per Stroke
c - 1.0 cc Less Fuel per Stroke

The technician should be able to correct most "bogging" problems with this 3-holed lever, providing the "bogging" is caused by the carburetor. When installing the 3-holed lever, remove any metal ball that someone may have put in the accelerator pump well to limit pump travel. Also, make sure that the duration spring on the accelerator pump is stock and hasn't had several coils cut off. Make sure the venturi cluster is the correct one as outlined in the correct Service Manual.

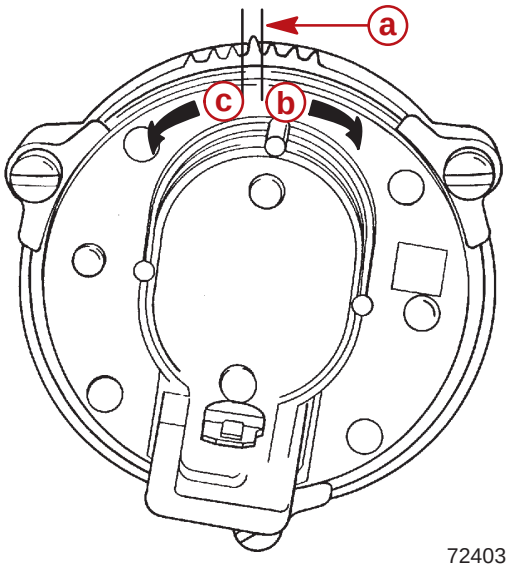
MerCarb

Choke System

DESCRIPTION

The choke system consists of a thermostatic coil assembly, electric heater coil, offset choke valve and linkage. Its operation is controlled by a combination of intake manifold vacuum, the off set choke valve, and temperature.

When the engine is cold, the thermostatic coil is calibrated to hold the choke valve closed. As the engine is started, air velocity against the offset choke valve causes it to open slightly against the torque of the thermostatic coil. The choke valve assumes a position where the torque of the thermostatic coil is balanced against the air velocity past the offset choke valve. The vacuum break position is when the choke valve is in this position and results in a regulated air flow into the carburetor. This regulated air flow provides the richer mixture needed during the warm-up period.



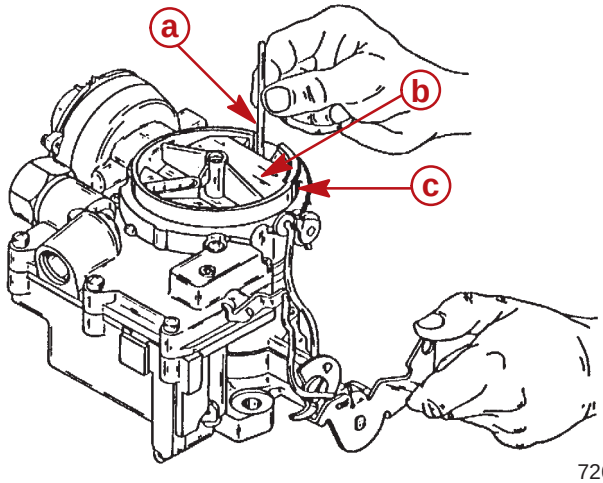
72403

a - Scribed Mark
b - More Choke
c - Less Choke

As the engine warms up, electrical current is supplied to the heater coil located next to the thermostatic coil. The electric current passing through the coils generates heat inside the thermostatic coils housing. This heat causes the thermostatic coil to relax its tension. Thus the choke valve is allowed to move gradually to the full open position.

During the warm-up period the air flow past the choke valve also serves to modify the choke action to compensate for varying engine loads on acceleration. Any acceleration or increased load decreases the vacuum pull on the choke valve. This allows the thermostatic coil to momentarily increase choke valve closure to provide the engine with a richer mixture for acceleration.

When the automatic choke is in operation the operator may wish to advance the throttle to wide open position. Since this would decrease pull upon the choke valve, thereby closing the choke valve, it is necessary to provide increased carburetor air flow by opening the choke valve mechanically. To accomplish this, a tang on the fast cam is made to contact the throttle lever at wide open throttle to sufficiently open the choke valve. This is called a choke unloader and also serves to de-choke a flooded engine during starting, whenever the engine is cranked with the throttle handle held at the wide open throttle position.



72684

a - .080 In. (0.2 mm) Drill Rod
b - Choke Plate
c - Air Horn

NOTES:

Fuel Systems – Carburetors

Rochester Quadrajet

The Quadrajet is a 4-barrel, two-stage carburetor of downdraft design. Its simplicity in construction makes it easy to service, yet its versatility and principles of operation make it adaptable from small to very large engines.

The Quadrajet carburetor has two stages of operation. The primary (fuel inlet) side has small 1-3/8” bores with a triple venturi set-up equipped with plain tube nozzles. Operation is similar to most carburetors using the venturi principle. The triple venturi stack up, plus the small primary bores, result in more stable and finer fuel control during idle and part throttle operation. During off-idle and part throttle operation, fuel metering is accomplished with tapered metering rods, operating in specially designed jets positioned by a manifold vacuum responsive piston.

An air valve is used in the secondary side for metering control and supplements the primary bores to meet air and fuel requirements of the engine. The secondary air valve mechanically operates tapered metering rods which move in orifice plates, thereby controlling fuel flow from the secondary nozzles in direct proportion to air flowing through the secondary bores.

The float bowl is centrally located to avoid problems of fuel spillage causing engine cut out and delayed fuel flow to the carburetor bores. The float bowl reservoir is smaller in design than most earlier 4-barrel carburetors to reduce fuel evaporation loss during engine “shut-down” hot.

The float system has a single pontoon float and fuel valve for simplification and ease in servicing. An integral fuel filter located in the float bowl ahead of the float needle valve is easily removed for cleaning or replacement.

The throttle body is aluminum to reduce overall weight and improve heat conduction to prevent icing. A heat insulator gasket is used between the throttle body and bowl to prevent fuel percolation in the float bowl.

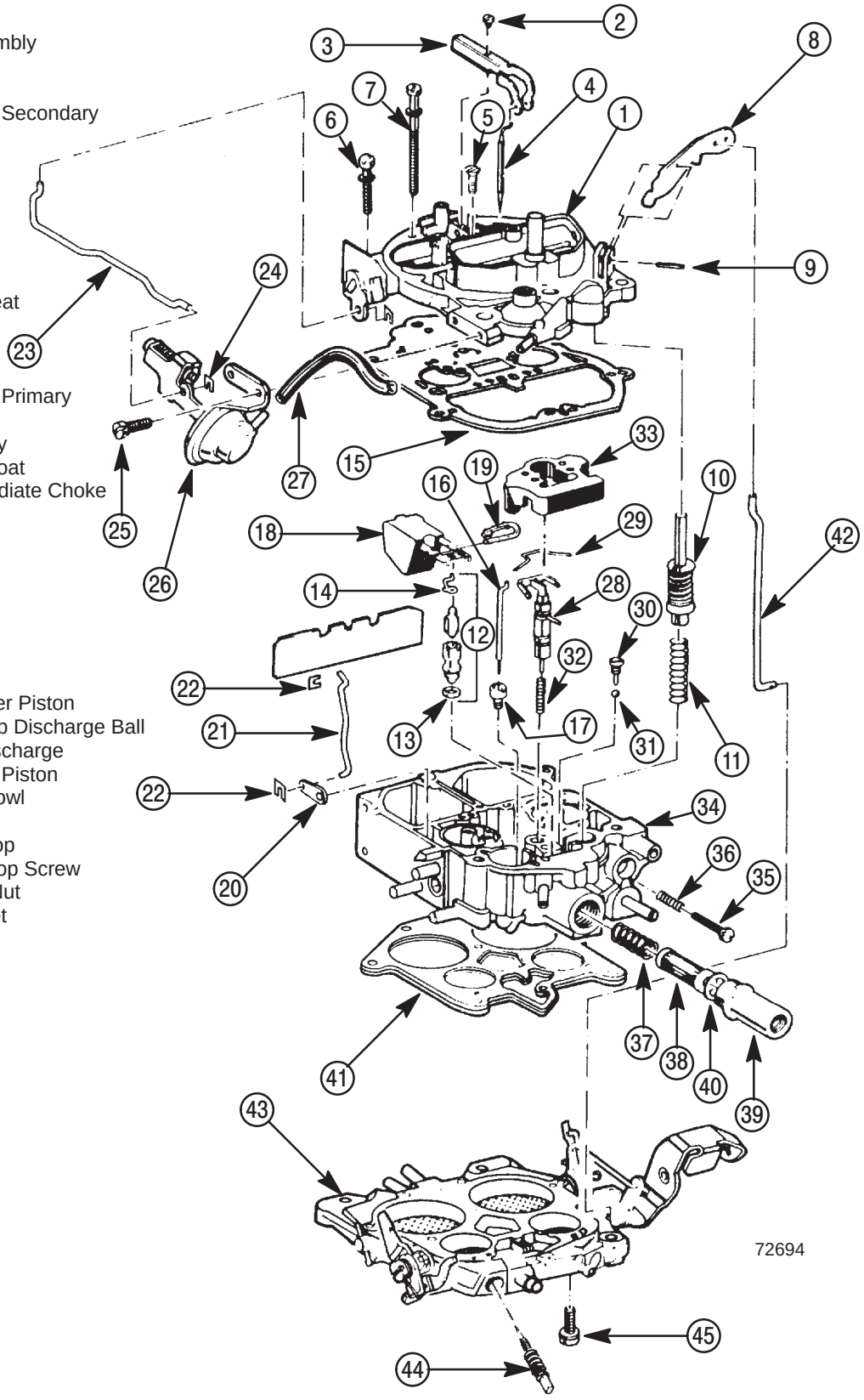
Many Quadrajet applications use a shim between the throttle body and flange gasket. The shim is used to protect the carburetor aluminum throttle body from exhaust gasses flowing through the heat crossover passage in the intake manifold.

The primary side of the carburetor has six operating systems. They are float, idle, main metering, power, pump, and choke. The secondary side has one main metering system plus accelerating wells on some models. All metering systems receive fuel from the one float chamber.

NOTE: *The 4MV and 4MC Quadrajets are 4 barrel, 2 stage carburetors. Both the 4MV and 4MC are of the same design, the only real difference being in the choke operation. The 4MV has a manifold mounted choke thermostat housing, and a link rod attaching the thermostat spring to the carburetor choke linkage. The 4MC has the choke thermostat housing mounted directly on the airhorn of the carburetor. The thermostat spring is hooked directly to the carburetor choke linkage.*

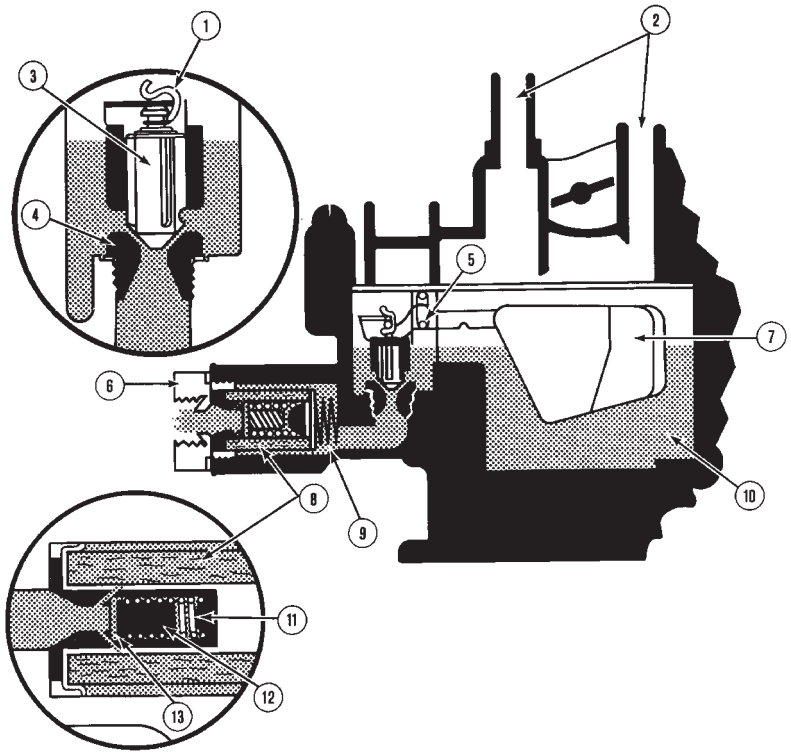
Rochester Quadrajet (4MV) Carburetor Exploded Parts View

1 - Air Horn Assembly
2 - Screw
3 - Hanger
4 - Metering Rod, Secondary
5 - Screw
6 - Screw
7 - Screw
8 - Lever
9 - Roll Pin
10- Pump
11- Spring
12- Needle and Seat
13- Gasket
14- Pull Clip
15- Gasket
16- Metering Rod, Primary
17- Jet, Primary
18- Float Assembly
19- Pin, Hinge - Float
20- Lever, Intermediate Choke
21- Rod
22- Clip
23- Rod
24- Clip
25- Screw
26- Control
27- Hose
28- Power Piston
29- Retainer, Power Piston
30- Retainer, Pump Discharge Ball
31- Ball, Pump Discharge
32- Spring, Power Piston
33- Insert, Float Bowl
34- Float Bowl
35- Screw, Idle Stop
36- Spring, Idle Stop Screw
37- Spring, Filter Nut
38- Filter, Fuel Inlet
39- Nut, Fuel Inlet
40- Gasket
41- Gasket
42- Rod
43- Throttle Body
44- Idle Needle
45- Screw



Rochester Quadrajet

Float System



The float system operates in the following manner:

Fuel from the engine fuel pump enters the carburetor fuel inlet passage. It passes through the filter element (8), fuel inlet valve (3) & (4) and on into the float bowl chamber (10). As the incoming fuel fills the float bowl to the prescribed level, the float pontoon (7) rises and forces the fuel inlet valve closed, shutting off fuel flow. As fuel is used from the float bowl, the float drops allowing the float valve to open, allowing more fuel to again fill the bowl. This cycle continues, maintaining a constant fuel level in the float bowl.

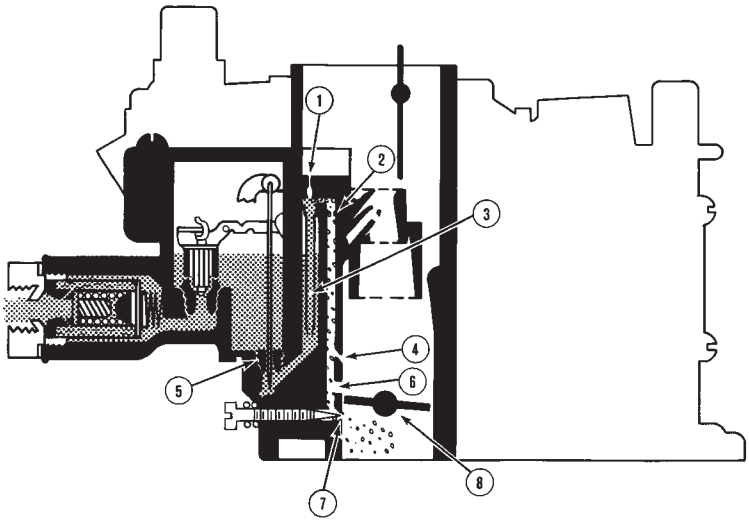
The float pontoon is solid and is made of a light weight closed cell plastic material. This feature gives added buoyancy to allow the use of a single float to maintain constant fuel levels. A float clip (1), fastened to the float valve, hooks over the edge of the float arm at the center. Its purpose is to assist in lifting the float valve off its seat whenever fuel level in the float bowl is low.

The plastic filler block is located in the top of the float chamber over the float valve to prevent fuel slosh into this area.

The carburetor float chamber is internally vented on all models through a vent tube or tubes (2) located on the air horn. The internal vent tube(s) leads from beneath the flame arrestor to the float bowl chamber. The purpose is to balance air pressure acting on the fuel in the bowl with air flow through the carburetor bores. In this way, balanced air/fuel mixtures ratios can be maintained throughout all carburetor ranges.

Rochester Quadrajet

Idle System



The Quadrajet carburetor has an idle system on the primary side (fuel inlet side) of the carburetor to supply the correct air/fuel mixture ratios during idle and off-idle operation. The idle system is used during this period because air flow through the carburetor venturi is not great enough to obtain efficient metering from the main discharge nozzles.

The idle system is used in the two primary bores of the carburetor. Each bore has a separate and independent idle system.

During idle, the throttle valves (8) are held slightly open by the idle speed adjusting screw. The small amount of air passing between the primary throttle valves and bores is regulated by this screw. Since the engine requires very little air for idle and low speeds, fuel is added to the air to produce a combustible mixture by the direct application of vacuum (low pressure) from the engine manifold to the idle discharge holes (7) below the throttle valves. With the idle discharge holes in a very low pressure area and the fuel in the float bowl vented to atmosphere (high pressure), the idle system operates as follows:

Fuel flows from the float bowl down through the main metering jets (5) into the main fuel wells by the two idle tubes (3) (one for each primary bore) which extend into the wells. The fuel is metered at the lower tip of the idle tube and passes up through the tube. The fuel is mixed with air at the top of each idle tube through an idle air bleed (1). The air bleed size is controlled either by a drilled hole or a brass insert depending upon the carburetor application.

Then the fuel mixture crosses over to the idle down channels where it is mixed with air at the side idle bleed located just above the idle channel restriction (2). The mixture continues down through the calibrated idle channel restrictions past the lower idle air bleeds (4) and off-idle discharge ports (6) where it is further mixed with air. The air/fuel mixture moves down to the adjustable idle mixture needle discharge holes (7) where it enters the carburetor bores and blends with the air passing the slightly open throttle valves. The combustible air/fuel mixture then passes through the intake manifold to the engine cylinders.

Turning the idle mixture needles inward (clockwise) decreases the fuel discharge (gives a leaner mixture) and turning the mixture needles outward (counterclockwise) enriches the engines idle mixture.

(cont.)

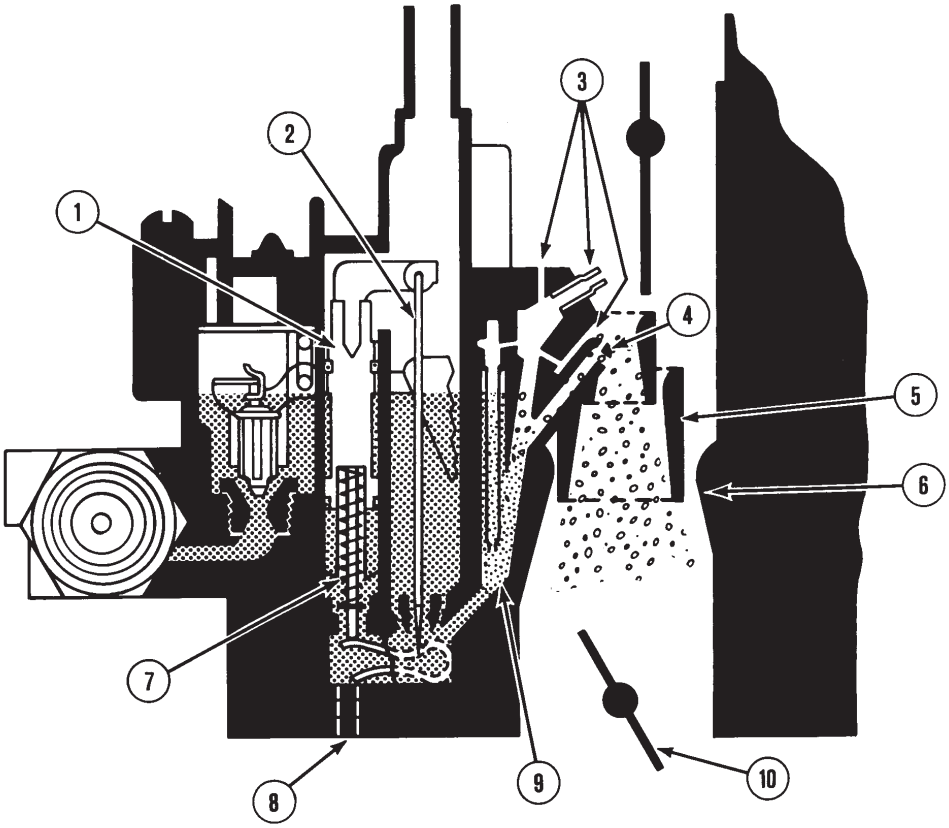
As the primary throttle valves are opened from low idle to increased engine speed, additional fuel is needed to combine with the extra air entering the engine. This is accomplished by the slotted off-idle discharge ports. As the primary throttle valves open, they pass by the off-idle ports, gradually exposing them to high engine vacuum below the throttle valves. The additional fuel, added from the off-idle ports, mixes with the increasing air flow past the opening throttle valves to meet increased engine air and fuel demands.

Further opening of the throttle valves increases the air velocity through the carburetor venturi sufficiently to cause low pressure at the lower idle air bleeds. As a result, fuel begins to discharge from the lower idle air bleed holes and continues to do so throughout operation of the part throttle to wide open throttle ranges, supplementing the main discharge nozzle delivery.

The idle needle holes and off-idle discharge ports continue to supply sufficient fuel for engine requirements until air velocity is high enough in the venturi area to obtain efficient fuel flow from the main metering system.

Rochester Quadrajet

Main Metering System



The main metering system supplies fuel to the engine from off-idle to wide-open throttle. The primary bores (two smaller bores) supply fuel and air during this range through plain tube nozzles and the venturi principle.

The multiple venturi in each primary bore produce excellent fuel metering control due to their sensitivity to air flow.

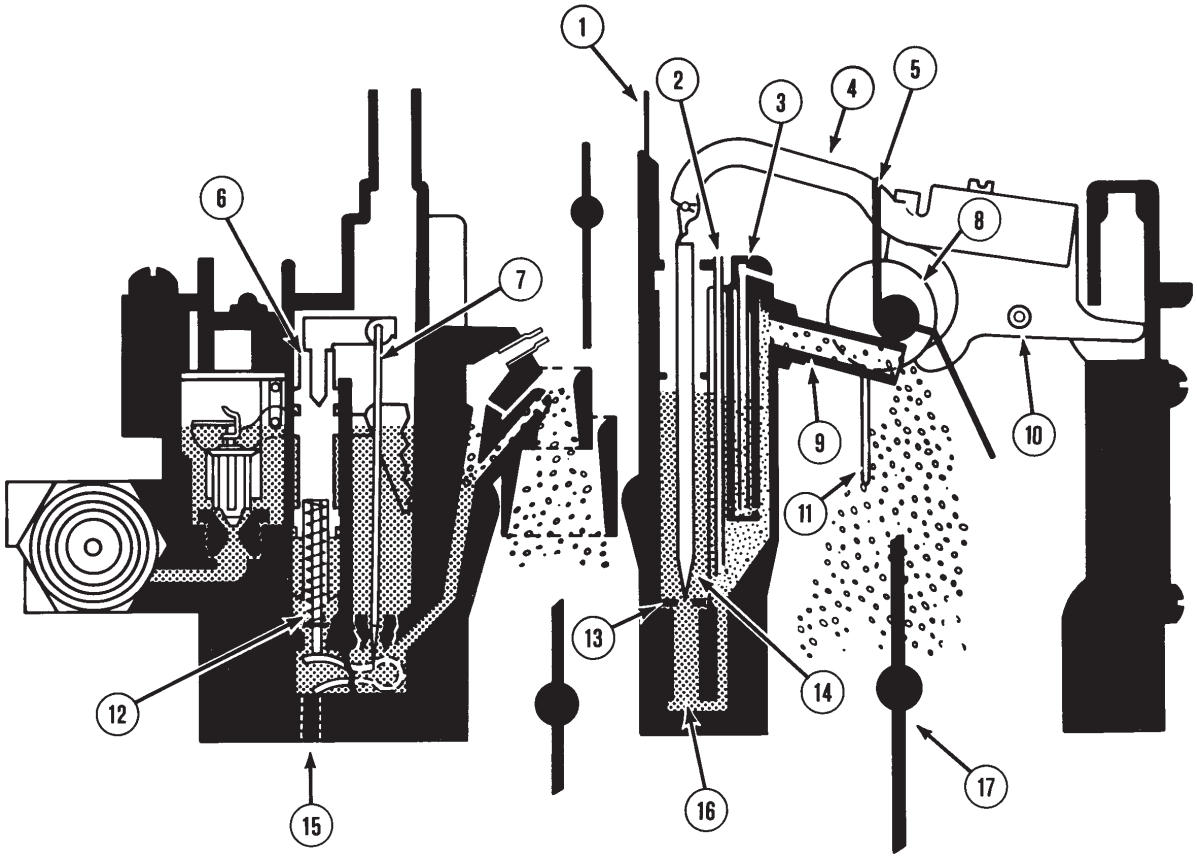
(cont.)

As the primary throttle valves (10) are opened beyond the off-idle range allowing more air to enter the engine intake manifold, air velocity increases in the carburetor venturi. Since the low pressure (vacuum) is now in the smallest boost venturi (5), fuel flows from the main discharge nozzle (4) as follows:

Fuel from the float bowl flows through the main metering jets into the main fuel wells (9). It passes upward in the main well and is bled with air by an air bleed (3) located at the top of the well. The fuel is further bled air through calibrated air bleeds located near the top of the well in the carburetor bores. The fuel mixture then passes from the main well through the main discharge nozzles (4) into the boost venturi. At the boost venturi, the fuel mixture then combines with the air entering the engine through the carburetor bores. It then passes as a combustible mixture through the intake manifold and on into the engine cylinders. The main metering system is calibrated by tapered and stepped metering rods (2) operating in the main metering jet and also through the main well air bleeds.

Rochester Quadrajet

Power System



The power system in the Quadrajet carburetor provides extra mixture enrichment to meet power requirements under heavy engine loads and high speed operation. The richer mixtures are supplied through the main metering systems in the primary and secondary sides of the carburetor.

The fuel mixture is enrichened in the two primary bores through the power system. This consists of a vacuum operated power piston (6) and a spring located in a cylinder connected by a passage to intake manifold vacuum. The spring (12) under the power piston pushes the piston upward against manifold vacuum force tending to pull the piston downward.

During part throttle and cruising ranges, manifold vacuums are sufficient to hold the power piston down against spring tension so that the larger diameter of the primary metering rod tip (7) is held in the main metering jet orifice to provide leaner mixtures during these periods of engine operation. However, as engine load is increased to a point where extra mixture enrichment is required, the power piston spring overcomes the vacuum pull on the power piston and the tapered tip of the primary metering rods moves upward in the main metering jet orifice.

The smaller diameter of the metering rod tip allows more fuel to pass through the main metering jet and enrichen the fuel mixture to meet the added power requirements. As engine load decreases, the manifold vacuum (15) rises and extra mixture enrichment is no longer needed. The higher vacuum pulls downward on the power piston against spring tension, which moves the larger diameter of the metering rod into the metering jet orifice returning the fuel mixture to normal economy ranges.

(cont.)

The primary side of the carburetor provides adequate air and fuel for low speed operation. However, at higher speed, more air and fuel are needed to meet engine demands. The secondary side of the carburetor is used to provide extra air and fuel through the secondary throttle bores.

The secondary section of the Quadrajet has a separate and independent metering system. It consists of two large throttle valves (17) connected by a shaft and linkage to the primary throttle shaft. Fuel metering is controlled by spring loaded air valves (5), metering orifice plates (13), secondary metering rods (14), main fuel wells with bleed tubes, fuel discharge nozzles (9), accelerating wells and tubes. The secondary metering system supplements fuel flow from the primary side and operates as follows:

When the engine reaches a point where the primary bores cannot meet the engine air and fuel demands, a lever on the primary throttle shaft, through a connecting link to the secondary throttle shaft, begins to open the secondary throttle valves. As the secondary throttle valves are opened, engine manifold vacuum (low pressure) is applied directly beneath the air valves. Atmospheric pressure on top of the air valves, forces the air valves open against spring tension and allows metered air to pass through the secondary bores of the carburetor.

In most models, accelerating wells are used to supply fuel immediately to the secondary bores. This prevents a momentary leanness until fuel begins to feed from the secondary discharge nozzles. When the air valves begin to open, the upper edge of each valve passes the accelerating well ports (11) (one for each bore). As the edge of the air valve pass the ports, they are exposed to manifold vacuum and immediately feed fuel from the accelerating wells located on each side of the float bowl chamber. The accelerating well is easily depleted. Each accelerating well has a calibrated orifice which meters the fuel supplied to the well from the float chamber.

The secondary main discharge nozzles (one for each bore) are located just below the center of the air valves and above the secondary throttle valves. The nozzles, being located in a low pressure area, feed fuel as follows:

As the secondary throttle valves are opened, atmospheric pressure opens the air valves. This rotates a plastic eccentric cam (8) attached to the center of the air valve shaft. As the cam rotates, it lifts the secondary metering rods out of the secondary orifice plates through the metering rod lever (10) which follows rotation of the cam.

Fuel flows from the float chamber through the secondary metering orifice plates into the secondary main wells where it is mixed with air from the secondary main well air bleed tubes (3). The air emulsified fuel mixture travels from the main wells through the secondary discharge nozzles (9) where it sprays into the secondary bores. Here the fuel is mixed with air traveling through the secondary bores to supplement the air/fuel mixture delivered from the primary bores and goes on into the engine as a combustible mixture.

As the throttle valves are opened further and engine speeds increase, air flow through the secondary side increases and opens the air valves to a greater degree which in turn lifts the secondary metering rods further out of the orifice plates. The metering rods are tapered so that fuel flow through the secondary metering orifice plates is directly proportional to air flow through the secondary carburetor bores. In this manner, correct air/fuel mixtures through the secondary bores are controlled by the depth of the metering rods in the orifice plates.

The depth of the metering rods on the orifice plates in relation to the air valve position are factory adjusted to meet air/fuel requirements for each specific engine model.

(cont.)

There are other features incorporated in the secondary metering system as follows:

1. The secondary main well air bleeds tubes extend downward into the main fuel well below normal fuel level. These bleed air into the fuel in the secondary wells to quickly emulsify the fuel with air for good atomization and improved fuel flow from the secondary nozzles.
2. There are two baffle plates in each secondary bore located just below the air valves. They extend up and around the secondary discharge nozzles. their purpose is to provide good fuel distribution at lower air flows by providing, as near as possible, equal fuel distribution to all engine cylinders.
3. An air horn baffle is used on some models to prevent incoming air from the flame arrestor reacting on the secondary main well bleed tubes. The baffle is located adjacent to the secondary well bleed tubes and extends above the air horn between the primary and secondary bores. This prevents incoming air from forcing the fuel down in the secondary wells through the bleed tubes and prevents secondary nozzle lag on heavy acceleration.

Rochester Quadrajet

Air Valve Dashpots

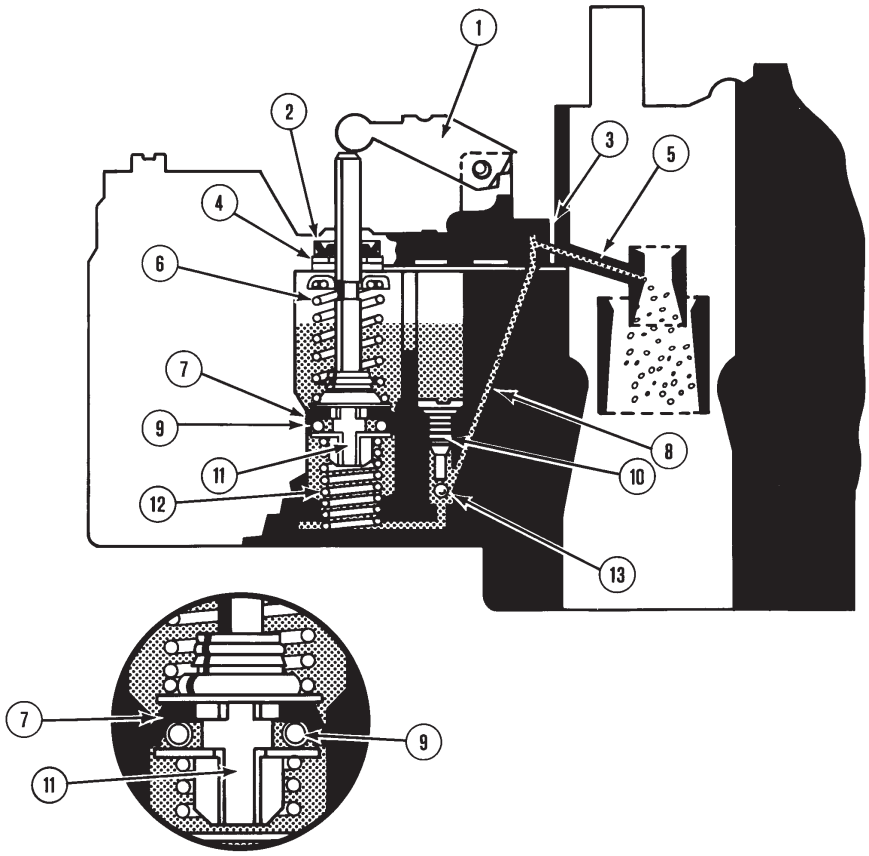
The primary purpose is to control the opening rate of the air valves and prevent secondary discharge nozzle lag.

The valve dashpot operates off of the choke vacuum break diaphragm unit. The secondary air valve is connected to the choke vacuum break unit by a rod, to control the opening rate of the air valve. Whenever manifold vacuum is above approximately 5” - 6” of Mercury (Hg), the vacuum break diaphragm is seated (plunger fully inward) against spring tension. At this point, the vacuum break rod is in the forward end of the slot in the air valve lever, or in the rear of the slot in the vacuum break plunger, and the air valves are closed.

During acceleration or heavy engine loads when the secondary throttle valves are opened, the manifold vacuum drops. The spring located in the vacuum break diaphragm overcomes the vacuum pull and forces the plunger and link outward which, in turn, allows the air valves to open. The opening rate of the air valves is controlled by the calibrated restriction in the vacuum inlet diaphragm cover. This gives the dashpot action required to delay air valve opening enough for efficient fuel flow from the secondary discharge nozzles.

Rochester Quadrajet

Accelerating Pump System



During quick acceleration, when the throttle is opened rapidly, the air flow and manifold vacuum change almost instantaneously. The fuel, which is heavier, tends to lag behind causing a momentary leanness. The accelerator pump is used to provide the extra fuel necessary for smooth operation during this time.

The accelerating pump system is located in the primary side of the carburetor. It consists of a spring loaded pump plunger and pump return spring, operating in a fuel well. The pump plunger is operated by a pump lever (1) on the air horn which is connected directly to the throttle lever by a pump rod.

When the pump plunger (11) moves upward in the pump well, as happens during throttle closing, fuel from the float bowl enters the pump well through a slot in the top of the pump well. It flows past the synthetic pump cup seal (7) into the bottom of the pump well. The pump cup is a floating type (the cup moves up and down on the pump plunger head). When the pump plunger is moved upward, the flat on the top of the cup unseats from the flat on the plunger head and allows free movement of fuel through the inside of the cup into the bottom of the pump well. This also vents any vapors which may be in the bottom of the pump well so that a solid charge of fuel can be maintained in the fuel well beneath the plunger head.

When the primary throttle valves are opened, the connecting linkage forces the pump plunger downward. The pump cup seats instantly and fuel is forced through the pump discharge passage, where it unseats the pump discharge check ball (13) and passes on through the passage (8) to the pump jets (5) located in the air horn where it sprays into the venturi area of each primary bore.

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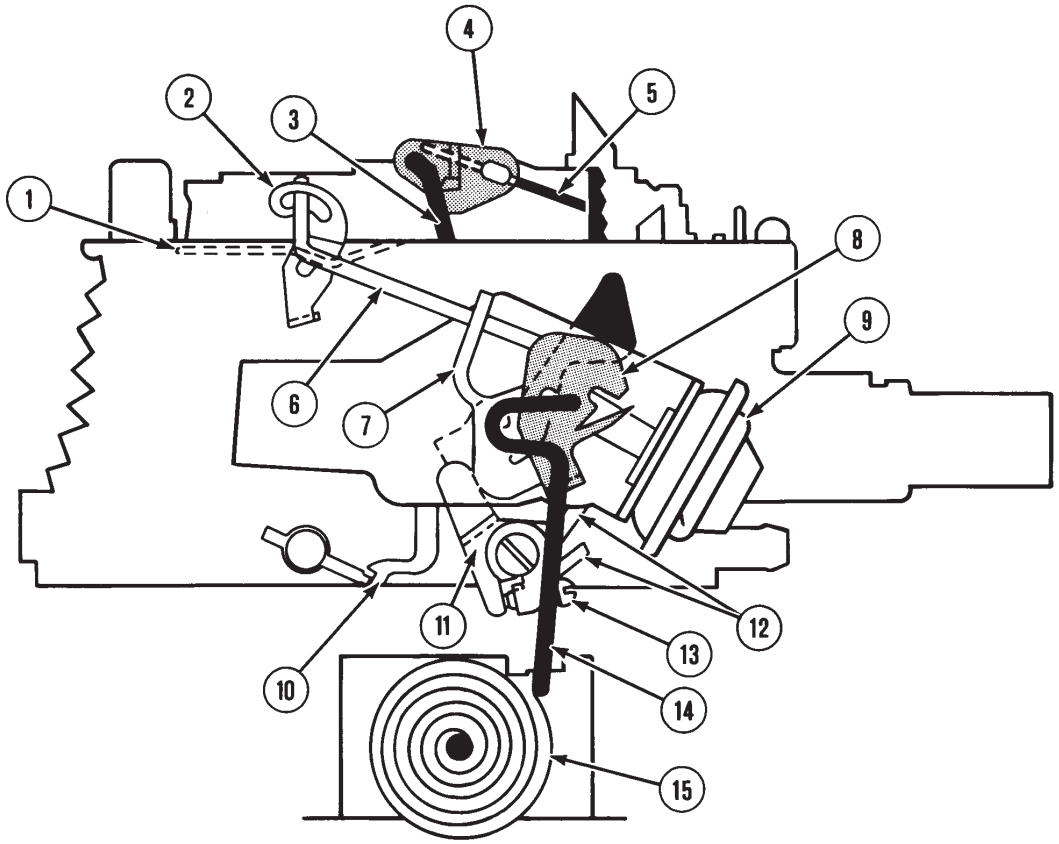
It should be noted the pump plunger is spring loaded. The upper duration spring (6) is balanced with the bottom pump return spring (12) so that a smooth sustained charge of fuel is delivered during acceleration.

The pump discharge check ball seats in the pump discharge passage during upward motion of the pump plunger so that air will not be drawn into the passage; otherwise, a momentary lag in acceleration could result.

During high speed operation, a vacuum exists at the pump jets. A cavity just beyond the pump jets (3) is vented to the top of the air horn, outside the carburetor bores. This acts as a suction breaker so that when the pump is not in operation, fuel will not be pulled out of the pump jets into the venturi area. This insures a full pump stream when needed and prevents fuel “pull over” from the pump discharge passage.

Rochester Quadrajet

Choke System



The Quadrajet choke valve is located in the primary side of the carburetor. The closed choke valve provides the correct air/fuel mixture enrichment to the engine for quick cold engine starting and (partially open) during the warm-up period.

The thermostatic coil is located in the engine manifold and is connected by a rod to the intermediate choke shaft and lever assembly.

Choke operation is controlled by the combination of intake manifold vacuum, the off-set choke valve, temperature, and throttle position.

The thermostatic coil located in the engine manifold is calibrated to hold the choke valve closed when the engine is cold.

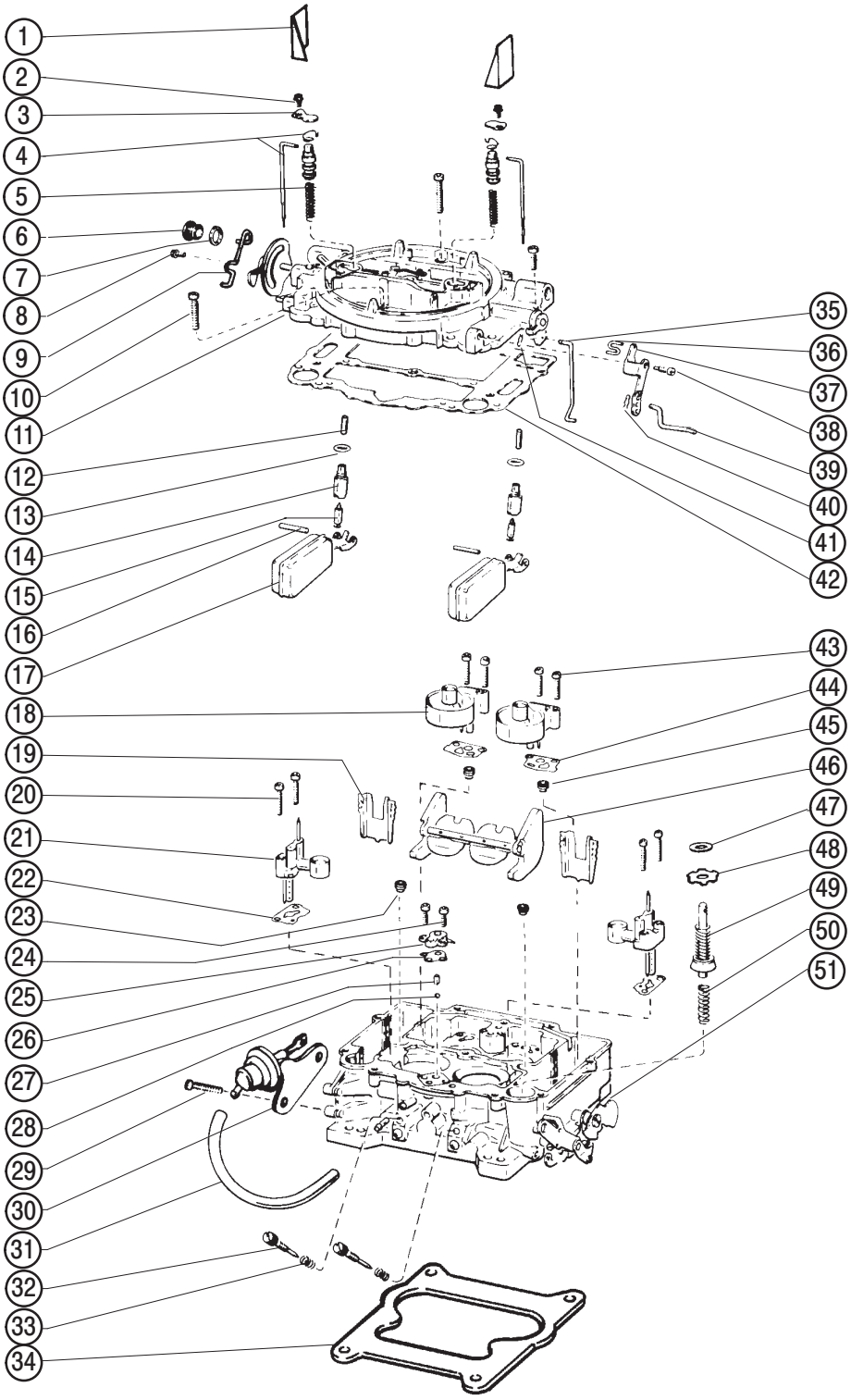
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During engine cranking, the choke valve is held closed by the tension of the thermostatic coil. This restricts air flow through the carburetor to provide a richer starting mixture.

When the engine starts and is running, the engine manifold becomes heated, it relaxes its tension and allows the choke valve to open further because of intake air pushing on the off-set choke valve. Choke valve opening continues until the thermostatic coil is completely relaxed, at which point the choke valve is wide open.

Weber Four-Barrel Carburetor - Exploded Parts View

The Weber carburetor is a square-bore design with equal size primaries and secondaries. The square-bore design provides better air/fuel distribution for improved low-end and mid-range response. The mid-range transition is controlled by a weighted air valve and is not adjustable.



1 - Air Deflector (2)
2 - Screw (2)
3 - Cover, Metering Rod (2)
4 - Metering Rod Assembly (2)
5 - Spring, Metering Rod (2)
6 - Fuel Inlet Fitting
7 - Sealing Washer
8 - Screw
9 - Linkage Rod, Choke Pull-Off
10- Screw
11- Air Horn (Carburetor Top)
12- Filter, Fuel Inlet (2)
13- Gasket (2)
14- Seat, Fuel Inlet (2)
15- Needle Valve, Fuel Inlet (2)
16- Pin (2)
17- Float (2)
18- Secondary Venturi Cluster (2)
19- Baffle Plate, Float Bowl (2)
20- Screw (4)
21- Primary Venturi Cluster (2)
22- Gasket (2)
23- Jet, Primary Fuel (2)
24- Screw (2)
25- Fuel Pump Injector Housing
26- Gasket
27- Check-Weight (or Check-Spring, if So Equipped)
28- Check-Ball
29- Screw
30- Diaphragm, Choke Pull-Off
31- Vacuum Hose
32- Idle Mixture Screw (2)
33- Spring, Idle Mixture Screw (2)
34- Gasket, Carburetor Base
35- Linkage Rod, Choke Plate
36- S-Link
37- Accelerator Pump Lever
38- Screw
39- Linkage Rod, Accelerator Pump
40- Wire Clip
41- Wire Clip
42- Gasket
43- Screw (4)
44- Gasket (2)
45- Jet, Secondary Fuel (2)
46- Secondary Air Valve and Weight Assembly
47- Plunger Washer
48- Plunger Guide
49- Accelerator Pump
50- Spring, Accelerator Pump
51- Float Bowl/Body (Carburetor Bottom)

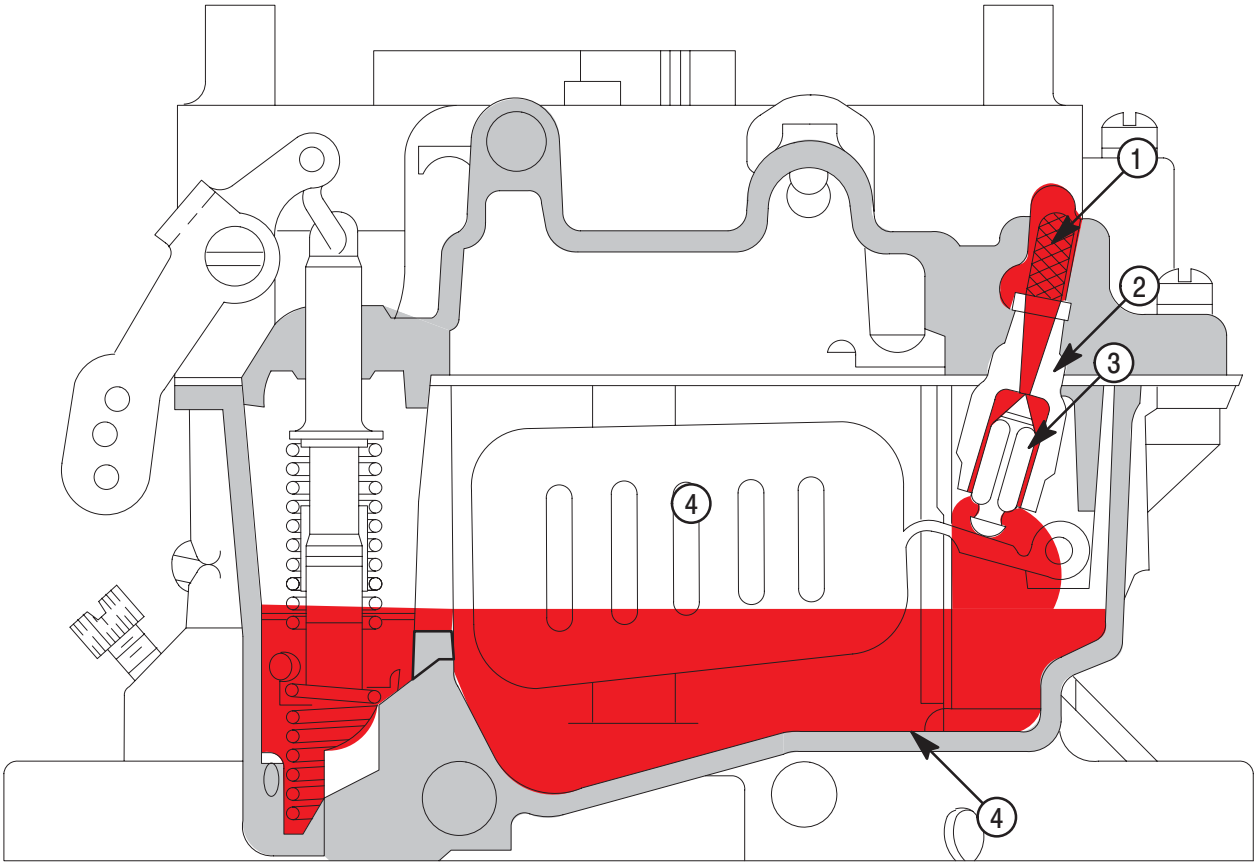
The carburetor body has two cast in float bowls. Each float bowl will feed a primary and a secondary circuit.

Fuel flowing through the primary jets feeds both the idle circuits and primary ventura. Fuel mixture for the idle circuit is controlled by mixture screws located in the front of the carburetor body. Fuel for the secondary circuit flows past two secondary fuel jets. (Extra fuel required by the Power Circuit is controlled by the metering rods in the air horn.)

Fuel Systems – Carburetors

Weber Carburetor

Float System



DESCRIPTION

The carburetor float system controls the fuel level in the carburetor bowl. Fuel level is very important because it must be maintained to give proper carburetor metering throughout all ranges of engine operation. If the fuel level is too high in the float bowl, problems such as rich mixtures affecting fuel consumption, fuel spillage from the main discharge nozzles on turns, and engine loading can result. If the fuel level is lower than the specified setting it can cause lean mixtures, hesitation on acceleration, engine surge, plus engine cut-out during heavy fuel demands. The Weber carburetor uses two float systems, both systems function identical.

The float system operates as follows:

Fuel from the engine fuel pump is forced through the fuel inlet filter (1), and on through the float needle seat (2), past the float needle (3), into the float bowl (4). Fuel flow continues until the fuel raises the float pontoon to a position where it forces the float needle against the needle seat and shuts off fuel flow. As fuel is used from the carburetor bowl, during engine operation, the float again drops downward, moving the float needle off its seat, allowing more fuel to flow into the float bowl, thereby keeping the fuel level constant.

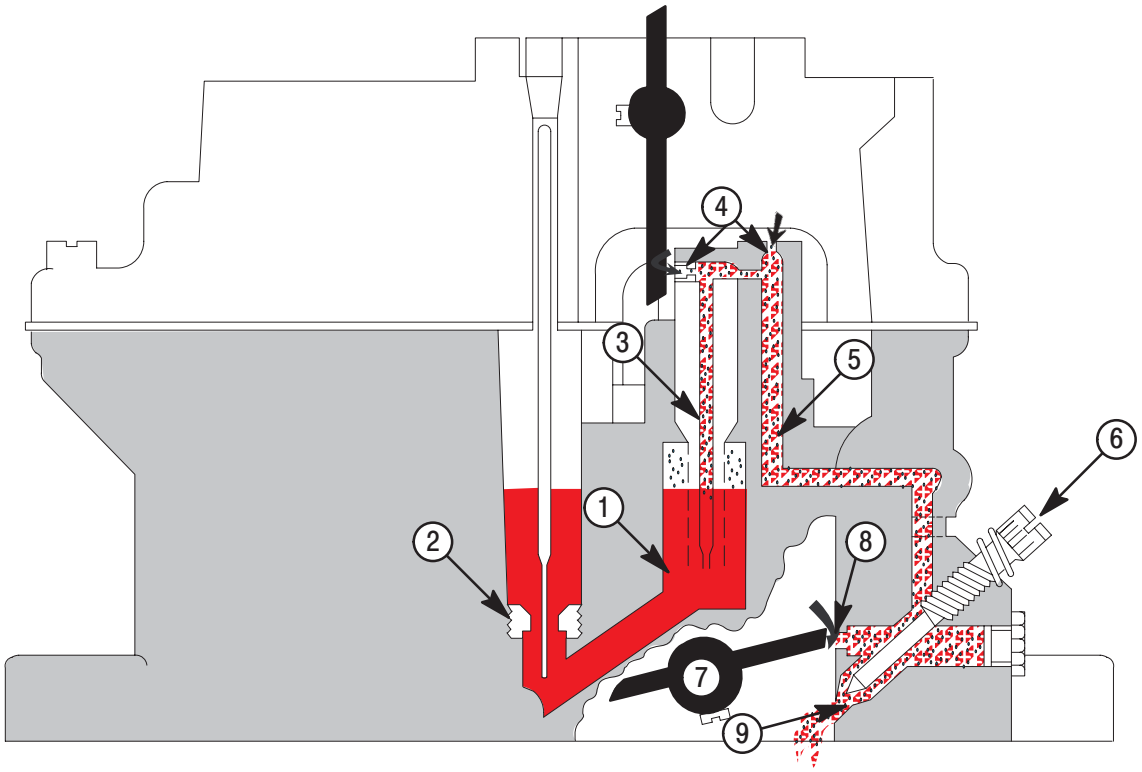
The float drop tang located at the rear of the float arm prevents the float from moving too far downward. The maximum float drop must be maintained so that the float assembly will drop sufficiently to allow maximum fuel flow under heavy engine demands.

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The bowl vent is internal inside the air horn just below the flame arrestor. The amount of fuel metered by the carburetor is dependant upon the pressure inside the float bowl causing the fuel to flow. The vent system assures that any pressure “build-up” in the float chamber during hot engine operation, caused by fuel vapors, will be relieved into the flame arrestor. During normal engine operation when the engine is running, manifold vacuum pulls the fuel vapors into the engine.

Weber Carburetor

Idle System



DESCRIPTION

The Weber Carburetor has an idle system to supply the correct air/fuel mixture ratios to the engine during idle and low speed operation. The idle system is necessary during this period because air flow through the carburetor venturi is not great enough to cause fuel to flow from the main discharge nozzles.

At idle speed the throttle valves (7) are held slightly open by the idle speed screw. The small amount of air which passes between the throttle valves and bores is regulated by the screw to give the desired idle speed.

Since the engine requires very little air for idle and low speed, fuel is added to the air by the application of vacuum (low pressure) from the intake manifold, directly through the idle system to the fuel in the carburetor float bowl. With the idle mixture screw (9) holes located in a high vacuum (low pressure) area below the throttle valves and fuel in the float bowl vented to atmosphere, the idle system operated in the following manner.

(cont.)

Fuel from the float bowl flows through the main metering jets (2), around the metering rods, into the main fuel well (1). It is then picked up and metered by the calibrated orifice at the tip of the idle tubes (3). It then passes up the idle tubes and is mixed with air from the air bleeds (4) located on the top of the idle tubes and in the idle cross channels. The mixture then passes downward in the idle channels (5) to the off-idle discharge slots (8). Here the fuel mixture is again bled with air and then moves to the idle mixture screw holes (9) where it is discharged and blends with the air passing the slightly open throttle valves and enters the intake manifold as a combustible mixture.

The idle mixture screw controls the amount of fuel mixture which enters each carburetor bore. If the idle mixture screw or needle is backed out, more mixture is admitted to the intake manifold and the engine runs rich. If the screw is turned in, the engine runs lean. In this manner, the idle mixture is varied for best idle.

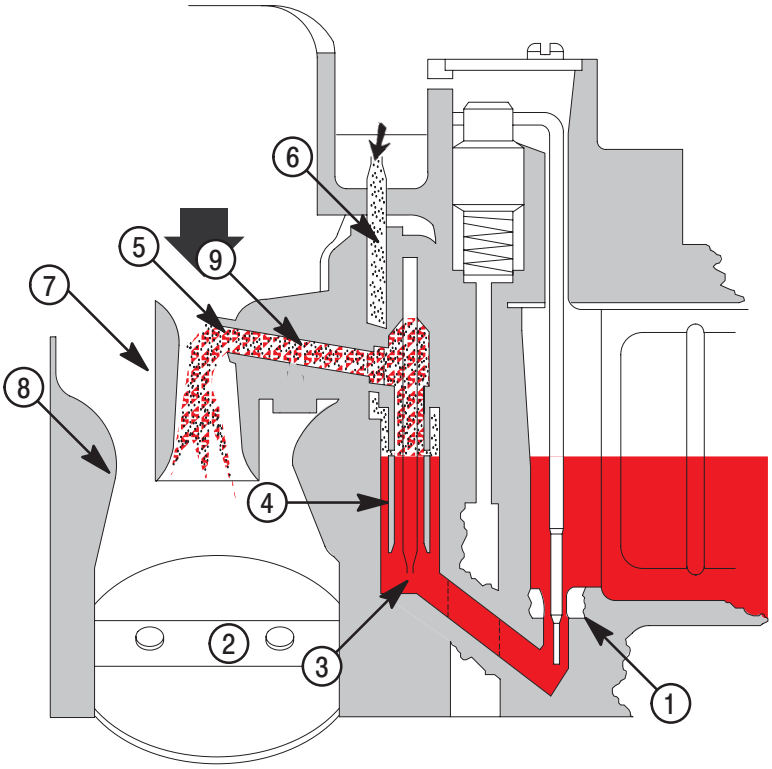
OFF-IDLE OPERATION

As the throttle valves are opened and more air is entering the engine to increase engine speed, additional fuel is needed to combine with the extra air. This is accomplished by the off-idle discharge slots. As the throttle valves move past the off-idle slots, they become progressively exposed to high vacuum below the throttle valves and the extra fuel needed is supplied by these slots.

The idle holes and off-idle slots supply sufficient fuel for engine requirements until air velocity is high enough in the venturi are to obtain fuel flow from the main metering system.

Weber Carburetor

Main Metering System - Primary Side



DESCRIPTION

The main metering system supplies fuel to the engine from off-idle to wide open throttle. The main metering system provides efficient fuel metering during the cruising range. Its operation is dependant upon air flow through the carburetor venturi (8) which, in turn, creates a low pressure in the venturi area causing fuel to flow.

As the throttle valves (2) are opened beyond the off-idle discharge slots, allowing more air to enter the intake manifold and engine speed to increase, the vacuum decreases below the throttle valves and the off-idle slots gradually diminishes.

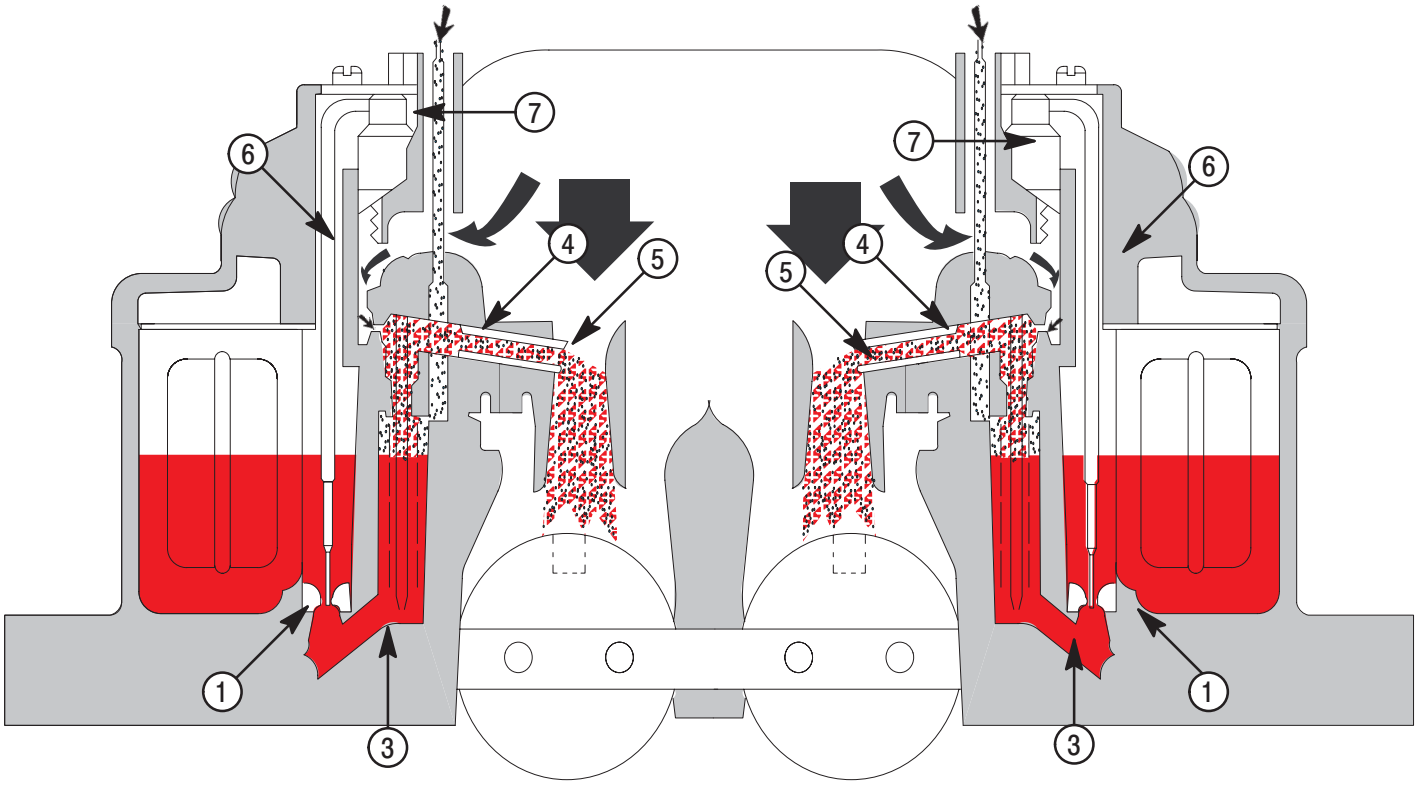
With the increases throttle opening, there is an increased air velocity in the venturi system. This causes a drop in pressure in the main venturi which is increased many times in the boost venturi, fuel will flow in the following manner.

The main discharge nozzle (5) is located in the low pressure area inside the boost venturi (7). Atmospheric pressure, which is greater, forces fuel from the float bowl through the main metering jets (1), around the primary metering rods and into the main well (3). As the fuel passes through the main well tubes (4), it is mixed with air from the calibrated main well bleeds (6). The fuel mixture then passes from the tip of the discharge nozzle (5), to the boost venturi (7) and on into the intake manifold.

As the throttle valve opening is increased, and more fuel is drawn through the main well tubes, the fuel in the main well drops. The calibrated holes in the main well tubes are proportionately exposed to the air in the upper well area. When this occurs, they become air bleeds mixing progressively more air with the fuel passing through the main well tubes. Therefore, although the nozzle suction is increased at higher engine speeds, the air/fuel mixture to the engine remains constant throughout part throttle range.

Weber Carburetor

High Speed Circuit - Power



DESCRIPTION

The power system in the Weber carburetor provides extra mixture enrichment to meet power requirements under heavy load and high speed operation. The richer mixtures are supplied through the main metering system. The spring-loaded power piston, (7) located in the cavity of the air horn, directly above the main jet (1), is held in the down position by engine manifold vacuum supplied directly through a connecting passage from the base of the carburetor. The power system is exposed to manifold vacuum at all times.

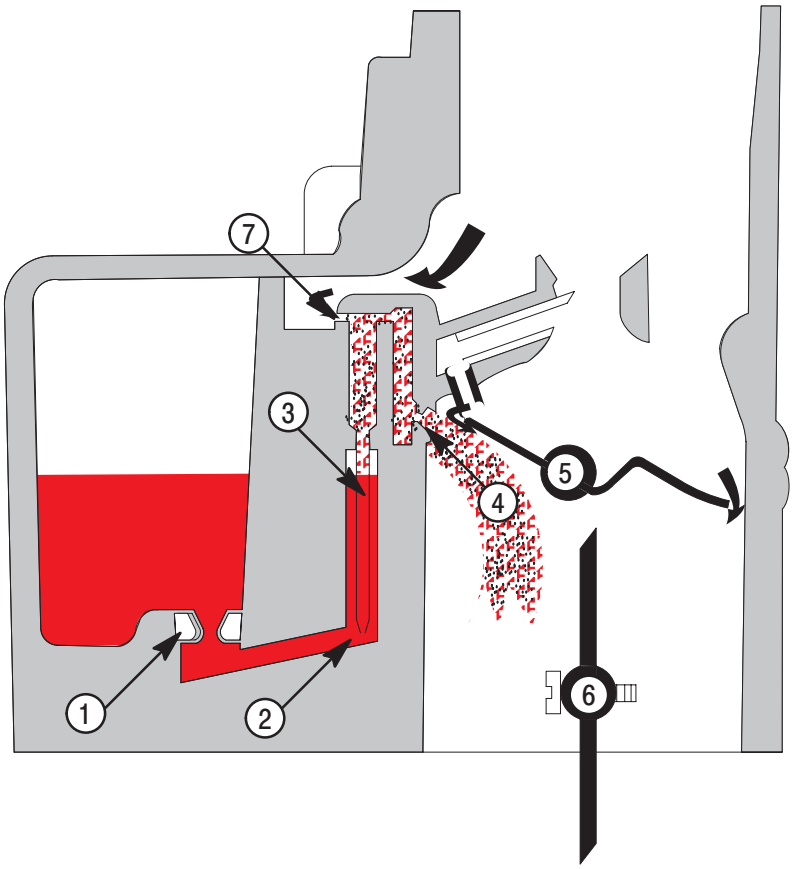
During idle and cruising ranges, the relatively high engine vacuum holds the power piston (and metering rod) in the down position against tension of a calibrated spring located on the power piston stem. During this period, the metering rod limits the amount of fuel allowed through the main jet.

Increases in engine load lower the manifold vacuum. When it has dropped sufficiently, the power piston spring overcomes the downward vacuum pull and the power piston moves upward, lifting the metering rod (6) and allowing additional fuel to flow through the main jets and on into the main well area (3). The fuel flowing through the power system is increased due to smaller diameters on the tips of the metering rods.

A hole drilled from the carburetor air horn to the bore of the power piston cavity to break any vacuum that might leak around the sides of the power piston. The purpose of the vacuum break hole is to prevent the transfer of vacuum from the piston to the top of the fuel in the float bowl. Any vacuum acting on the fuel in the float bowl will affect carburetor calibration.

Weber Carburetor

Secondary Initial Discharge

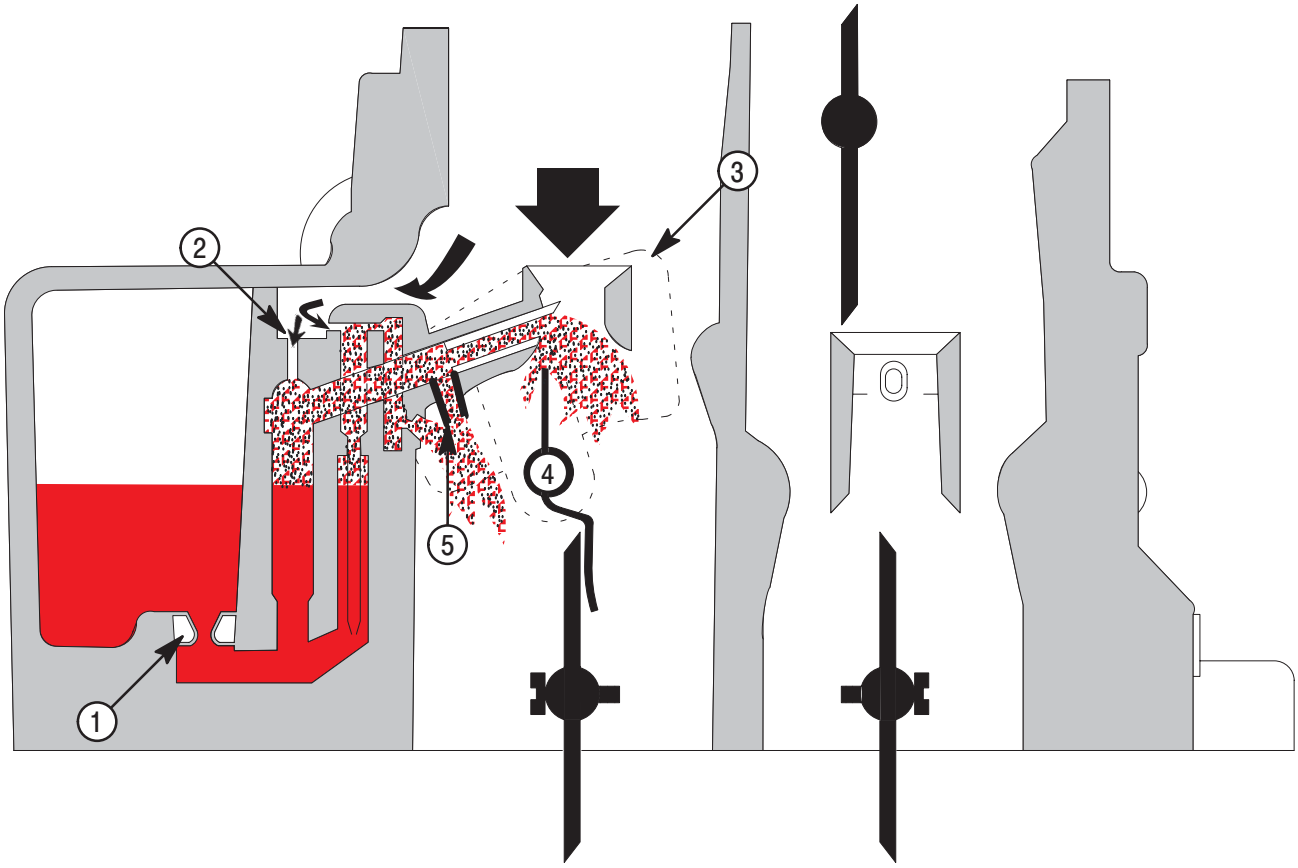


DESCRIPTION

As the throttle plate rotates (6), air flow increases past the auxiliary valve (5). The increased air flow creates a low pressure area around the secondary initial discharge port (4). Atmospheric pressure forces fuel from the float bowl through the secondary metering jet (1) and into the secondary fuel well (2). Air enters the fuel well through the air bleeds (7) and mixes with the fuel. This air fuel mixture is drawn into the air stream through the secondary initial discharge port (4).

Weber Carburetor

Auxiliary Valve Operation

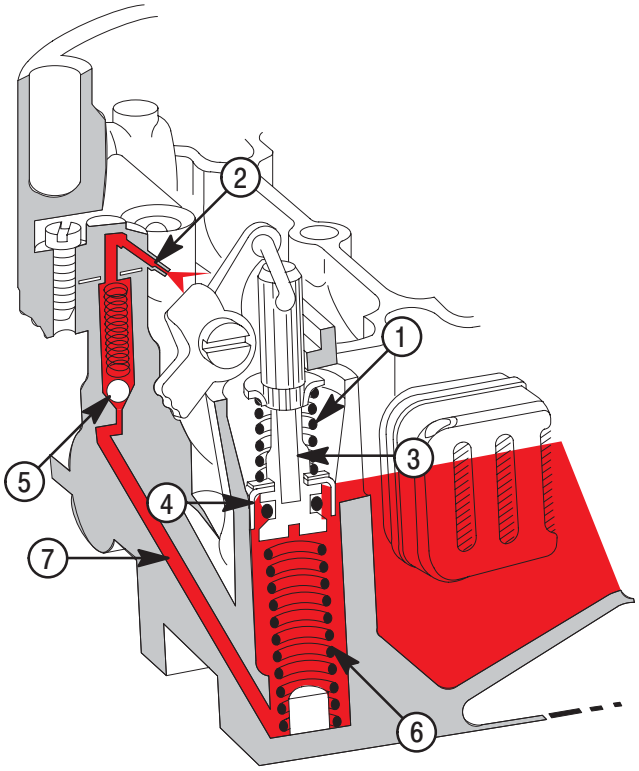


DESCRIPTION

As the engine speed increases, engine demand increases air flow through the secondary venturi. This air flow overcomes the counter weight and forces the auxiliary air valve (4) to rotate. Increased air flow through the secondary boost venturi (3) creates a low pressure area around the secondary discharge tube. Atmospheric pressure inside the float bowl forces fuel through the secondary jet (1) into the secondary fuel well. Air entering the air bleed (2) mixes with fuel inside the well, allowing an air/fuel mixture to be pulled into the secondary discharge tube and out the secondary main discharge port. Additional fuel is supplied thru the secondary strut ports (5) for part-throttle hard acceleration.

Weber Carburetor

Accelerator Pump



DESCRIPTION

During quick acceleration when the throttle is opened rapidly, the air flow and manifold vacuum change almost instantaneously, while the heavier fuel tends to lag behind causing a momentary leanness. The accelerator pump is used to provide the fuel necessary for smooth operation during this time.

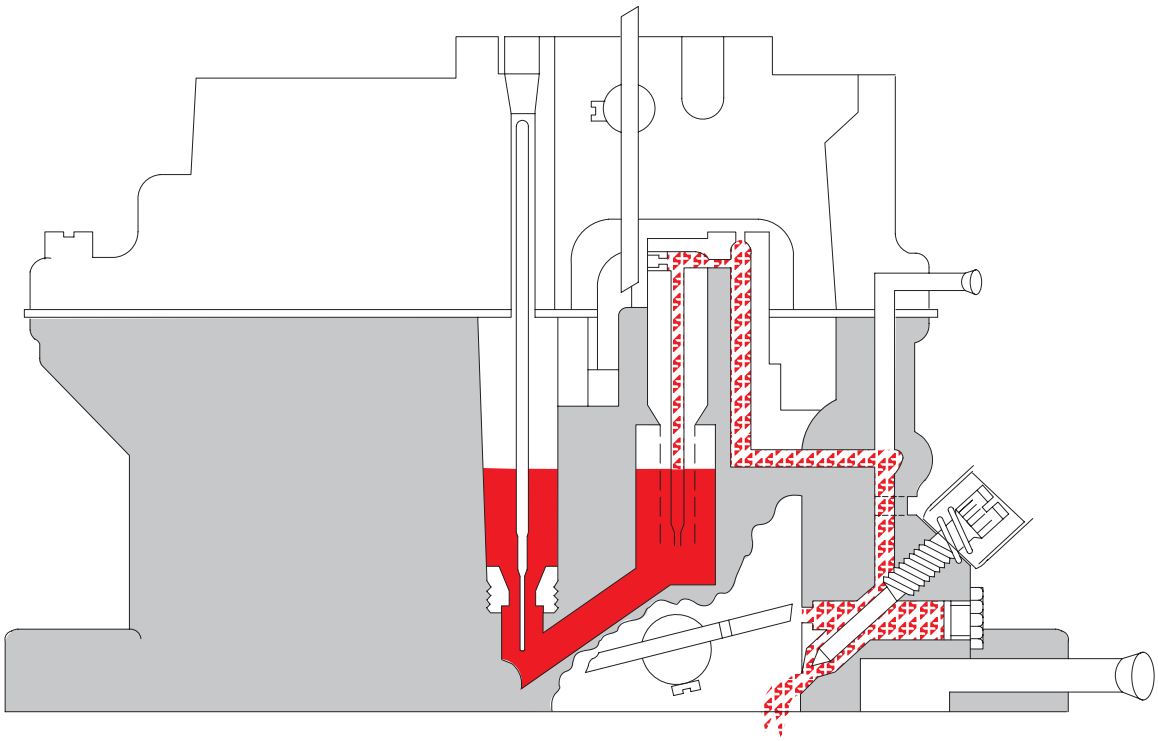
Fuel for acceleration is supplied by a double spring-loaded pump plunger (3) operated by a pump shaft and lever assembly, in the air horn, connected directly to the throttle lever by a pump rod. The top (1) and bottom (6) springs combine to move the plunger so that a smooth sustained charge of fuel is delivered for acceleration.

When the pump plunger moves upward as happens during throttle closing, fuel enters the slotted pump well, flows around the side of the pump plunger and into the bottom of the pump well.

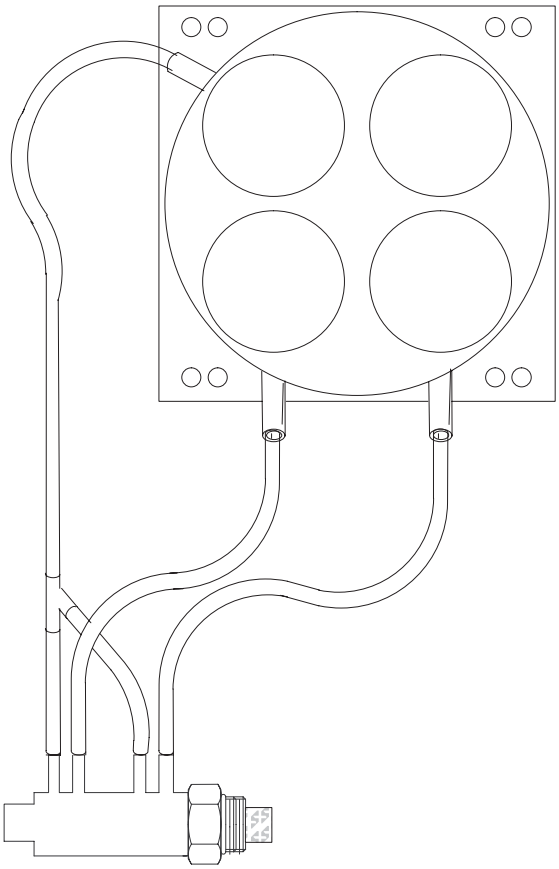
When the throttle valves are opened, the connecting linkage forces the pump plunger downward in the well. The downward motion of the plunger forces fuel into the pump discharge passage (7) and unseats the pump discharge check ball (5). Fuel then passes on through the passage to the pump jets (2) in the cluster where it sprays into the venturi area.

The pump discharge check ball is used in the pump discharge passage to prevent air from being drawn into the passage during upward movement of the pump plunger to prevent a momentary delay in delivery of fuel. The pump ball is held in the seated position by a spring or weight.

Weber Carburetor
Emissions



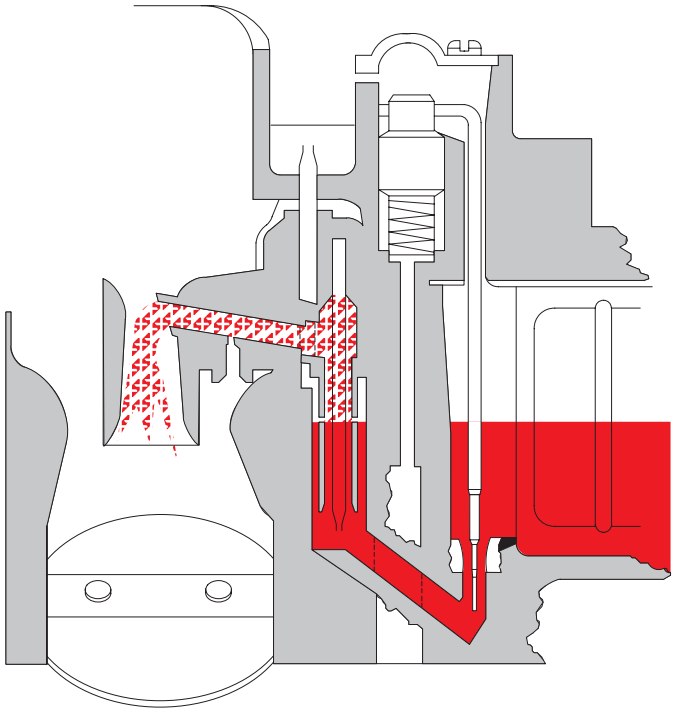
IDLE CIRCUIT



The PVS circuit is used with the idle circuit. When the engine is cold, the PVS circuit is closed. This shuts off a metered air-bleed to the idle circuit, to maintain a rich idle circuit for warm-up. Once the engine warms up [approximately 120^0 F (54^0 C)], the PVS opens, allowing a metered amount of air to be mixed into the idle circuit. This leans the idle circuit to the proper operating air-fuel ratio. (cont.)

The emission carburetor uses sealed idle mixture screws that prevent tampering with the idle mixture after the mixture has been properly adjusted.

EMISSIONS HIGH SPEED CIRCUIT



The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

ANSI/ABYC Standard H-24

"GASOLINE FUEL SYSTEMS"

[The following ABYC (ANSI) Standard #H-24, "Gasoline Fuel Systems" (Effective Date 12/96), has been reprinted with the permission of the American Boat and Yacht Council, Inc.]

For information on joining the ABYC, or for more information on the "Standards and Recommended Practices for Small Craft", contact the organization at:

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3069 Solomons Island Road,
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Phone: (410) 956-1050
Fax: (410) 956-2737

www.abycinc.org

(A membership application form is attached.)

ABYC Cover Sheet for "H-24"

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H-24 GASOLINE FUEL SYSTEMS

Based on ABYC's assessment of the existing technology, and the problems associated with achieving the goals of this standard, ABYC recommends compliance with this standard for all boats, associated equipment, and systems manufactured and/or installed after July 31, 1998.

24.1 *PURPOSE*

These standards and recommended practices are guides for the design, choice of materials for, construction, installation, and maintenance of gasoline fuel systems on boats.

EXCEPTION: Portable fuel systems covered by ABYC H-25, Portable Fuel Systems.

NOTE: The United States Coast Guard has promulgated mandatory requirements for gasoline fuel systems in Title 33 CFR Subpart J Sections CFR 183.501 - 183.590. (Refer to the CFR for complete, current federal requirements.)

24.2 *SCOPE*

These standards and recommended practices apply to all parts of installed gasoline fuel systems from the fuel tank fill opening to the point of connection to the propulsion engine and/or to any auxiliary equipment on inboard and outboard powered boats.

24.3 *REFERENCED ORGANIZATIONS*

ABYC - American Boat & Yacht Council, Inc., 3069 Solomons Island Road, Edgewater, MD 21037-1416. Phone: (410) 956-1050. Fax: (410) 956-2737. Web site: www.abycinc.org.

ASTM International – American Society for Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Phone: (610) 832-9585. Fax: (610) 832-955. Web site: www.astm.org.

American Welding Society, 550 NW 42nd Avenue (#100), Miami, FL 33126. Phone: (305) 443-9353. Fax: (305) 443-7559. Web site: aws.org.

CFR - Code of Federal Regulations and other government publications. Obtain from the Superintendent of Documents, United States Government Information, POB 371 954, Pittsburgh, PA 15250-7954. Phone: (202) 512-1800. Fax: (202) 512-2250.

Military Specifications - Military specifications may be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

SAE - Society of Automotive Engineers - 400 Commonwealth Drive, Warrendale, PA 15096-0001. Phone: (724) 776-4841. Fax: (724) 776-5760. Website: www.sae.org.

UL – Underwriters Laboratories, Inc., 12 Laboratory Drive, PO Box 13995, Research Triangle Park, NC 27709-3995. Phone: (919) 549-1400. Fax: (919) 547-6000. Web site: www.ul.com.

24.4 *DEFINITIONS*

Accessible - Capable of being reached for inspection, removal, or maintenance without removal of permanent boat structure.

Anti-siphon valve - A valve preventing a siphon action created by a break in the fuel distribution system below the topmost level of the fuel tank.

Fuel filter - A filtering device with a micron rating less than 500.

Fuel strainer/rock screen - A screening device to remove coarse debris from the fuel supply and still permit the passage of water.

Gasoline - Includes all gasoline based fuels. The Federal Hazardous Substance Act classifies gasoline as "extremely flammable," having a flash point at, or below, 20°F (-7°C).

Permanently installed - Securely fastened so that tools, such as wrenches and screwdrivers, must be used for removal.

Readily accessible - Capable of being reached quickly and safely for effective use under emergency conditions without the use of tools.

Static floating position - The attitude in which a boat floats in calm, fresh water, with fuel tanks filled to rated capacity, but with no person or item of portable equipment aboard. The boat should include all permanently installed, factory supplied equipment and options such as, but not limited to, the engine or engines, batteries, seats, engine oil, railings, fishing towers, etc., but not portable gear, such as flags, searchlights, movable cushions, mattresses, portable fire extinguishers, lines, fenders, chairs, tables, anchors, chain, or PFDs. Other tanks such as water, holding, and live bait well tanks are to be empty.

Water separator - A device to separate water from the fuel.

24.5 *REQUIREMENTS - IN GENERAL*

24.5.1 The installed fuel system shall be designed so that a fuel temperature rise of 60°F (33°C) shall not cause liquid fuel to spill into the boat or the environment when

24.5.1.1 the fuel tank is filled to its rated capacity according to the boat manufacturers' instructions, and

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24.5.1.2 the boat is in the static floating position,

NOTE: A fuel system designed to contain 5% fuel expansion will meet this requirement.

24.5.2 Fuel systems shall be liquid and vapor tight to the hull interior.

EXCEPTIONS: 1. Permeation of hoses within the limits of SAE J1527.

2. Permeation of fuel tanks within the limits of CFR 33, Subpart K, CFR 183.620 (a)(5)(i), and of ABYC H-2, Ventilation of Boats Using Gasoline.

24.5.3 Fuel systems shall be designed to withstand an ambient temperature range from -40°F (-40°C) to 176°F (80°C) without failure or leakage.

24.5.4 Valves or petcocks for drawing fuel from the system shall not be installed. See 24.9.3.

24.5.5 Metallic components used in a fuel system shall be corrosion resistant, or finished to inhibit corrosion, and shall be selected and assembled to minimize galvanic action.

24.5.6 Gaskets and joint sealers shall be designed to withstand exposure to ASTM Reference Fuel C for 30 days, at which time there shall be no leakage when subjected to the fuel system pressure in accordance with 24.17.4 for 24 hours.

24.5.7 All individual components of the fuel system, as installed in a boat, shall be capable of withstanding a 2½ minute exposure to free burning fuel (N-Heptane) without leakage as required by Title 33 CFR, Section CFR 183.590, and as required for individual components in H-24. See APPENDIX A.

EXCEPTIONS: 1. Portions of fuel distribution systems, if a break at any point in this system will result in the discharge of no more than five ounces of fuel in 2½ minutes including fuel that may drain from the engine.

2. Self-draining fill and vent pipes located in a separate compartment from the engine compartment.

3. Fill and vent external fittings.

4. Clips and straps not essential for anti-siphon protection required by this standard.

24.6 ***FLEXIBLE FUEL HOSE***

24.6.1 Hose shall comply with the requirements of the UL 1114, or with the requirements of SAE J1527.

24.6.2 Hose shall be marked on the outermost cover with the manufacturer's name or trademark, year of manufacture, the applicable hose marking in TABLE I , and UL 1114 or SAE J1527.

24.6.3 All required marking shall be legible and permanent on the hose itself at least every 12 inches (305mm) in block capitals and numerals at least 1/8 inch (3.16mm) high.

NOTE: Hoses less than 12 inches (305mm) in length may be tagged with the required marking.

24.7 ***FUEL LINE SUPPORTS***

24.7.1 Clips, straps, or other means used for securing fuel lines shall be of corrosion resistant material and of a design to eliminate cutting or abrading action where in contact with the fuel line.

24.7.2 Clips and straps used to hold fuel lines in position to maintain anti-siphon protection shall be capable of withstanding a 2½ minute fire test.

24.8 ***VALVES***

24.8.1 Valves shall pass the 2½ minute fire test as specified in Title 33 CFR, Section CFR 183.590, and 24.5.7.

24.8.1.1 Electrically operated valves shall meet the requirements of UL 429, *Electrically Operated Valves.*

24.8.2 The unit shall incorporate means for independent mounting designed to relieve strain from connected fuel lines.

24.8.3 Manually operated valves shall be designed with positive stops in the open and closed positions, or shall indicate their opened and closed positions.

24.8.4 Electrically operated shut-off valves shall be connected to be energized to open when the engine ignition switch is on. A provision for manual operation shall be incorporated in the design.

24.8.5 Tapered plug valves with an external spring shall not be used.

24.9 ***FUEL FILTERS, STRAINERS, AND WATER SEPARATORS***

24.9.1 The unit shall incorporate means for independent mounting.

24.9.2 The unit shall be designed so that routine servicing and removal for cleaning purposes will minimize, as much as practical, any spillage of fuel into the bilge.

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24.9.3 Drain openings shall be equipped with tapered pipe plugs. The plugs shall not create a galvanic cell with the housing that will accelerate corrosion.

24.9.4 All fitting threads shall be tapered pipe threads.

24.9.4.1 External threads shall be National Pipe Thread Fine (NPTF).

24.9.4.2 Internal threads shall be Pipe Thread Fine Short (PTF SPL SHORT).

24.9.5 Gaskets and Seals

24.9.5.1 Gaskets and seals, if used, shall form a complete ring, and shall not be split.

24.9.5.2 Cork gaskets shall not be used.

24.9.5.3 A gasket or "O" ring shall be retained by the body, or cover, when the part is removed.

24.9.6 Marking

24.9.6.1 Each unit shall be permanently and plainly marked with the following:

a. manufacturer's or private labeler's name or identifying symbol;
b. type of unit (filter, strainer, or separator);
c. replacement element part designation;
d. direction of fuel flow;
e. test pressure;
f. types of fuel for which the unit is intended;
g. installation and use instructions. These may be a separate sheet and shall contain a component parts replacement list;
h. date of manufacture.

NOTE: Filters, separators, and strainers meeting the requirements of ANSI/UL 1105, Marine Use Filters and Separators, comply with the requirements of 24.9 through 24.9.6.1.

24.10 ***INSTALLATION - FUEL TANK***

24.10.1 Fuel tank(s) shall be permanently installed so that the tanks(s) do not support decks, bulkheads, or other structures.

24.10.2 The tank(s) shall be installed so that means for maintenance or replacement is provided, or indicated so it can be accomplished with a minimum disturbance of the boat structure.

24.10.3 Tank connections and fittings shall be accessible.

24.10.4 As installed in the boat, tank labels shall be accessible and located so they can be read.

24.10.5 Fuel tanks shall be installed and restrained so that the fuel tank does not move at the mounting surface more than 1/4 inch (6.4mm).

EXCEPTION: Space required for expansion of new non-metallic fuel tanks.

24.10.6 All non-integral tank supports, chocks, or hangers shall be separated from the metallic tank surface by a non-metallic, non-moisture-absorbent, non-abrasive material suitable for the purpose, e.g., neoprene, Teflon, and high density plastics.

24.10.6.1 Self-wicking material, such as carpet pile, shall not be in contact with a metallic tank.

24.10.7 Metallic fuel tanks installed above flat surfaces shall be separated from the surfaces by at least 1/4 inch air space when filled with fuel, and the flat mounting surface shall be self-draining.

24.10.8 Each metallic tank must be installed to allow drainage of accumulated water from the tank's surfaces when the boat is in its static floating position.

24.10.9 Metal tanks shall be installed where they cannot be reached by normal accumulation of bilge water in the static floating position.

24.10.10 Aluminized steel tanks of less than .0785 inch (2mm) thickness shall be installed above the cockpit floors, or above deck, if there is not a clearly defined cockpit.

24.10.11 If a metallic fuel tank is encased in plastic,

24.10.11.1 the tank material may not be a ferrous alloy, and

24.10.11.2 the plastic must be attached to the metal surface of the tank so as to prevent moisture between the metal and the plastic, and

24.10.11.3 the adhesive strength of the metal to plastic bond must exceed the cohesive strength of the plastic, and

24.10.11.4 the fuel tank must be supported in the boat by means other than plastic foam.

24.10.12 Cellular plastic used to encase fuel tanks must:

24.10.12.1 Not change volume by more than 5 percent or dissolve after being immersed in any of the following liquids for 24 hours at 84.2°F (29°C);

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- Reference Fuel B of ASTM D-471, or
- No. 2 Reference Oil of ASTM D-471, or
- Five percent solution of trisodium phosphate in water; and must

24.10.12.2 not absorb more than 0.12 pound of water per square foot of cut surface measured under Military Specification MIL P-21929B.

24.10.13 Non-polyurethane cellular plastic, if used to encase fuel tanks, must have a compressive strength of at least 60 pounds per square inch at 10 percent deflection, measured under ASTM D-1622, *Apparent Density of Rigid Cellular Plastics.*

24.10.14 Polyurethane cellular plastic, if used to encase fuel tanks, must have a density of at least 2.0 pounds per cubic foot, measured under ASTM D-1622, *Apparent Density of Rigid Cellular Plastics.*

24.10.15 A means to determine fuel level or quantity shall be provided.

24.11 ***CONNECTIONS - FUEL HOSE***

24.11.1 Flexible hose not equipped with permanently attached end fittings, such as swaged sleeve and threaded insert, shall be attached with corrosion resistant metallic clamps.

NOTE: Some hose that meets the requirements of UL 1114 is not designed to be clamped.

24.11.2 The ID of a hose and the OD of a connecting spud or fitting must meet the specification in Table II.

24.11.3 Hose shall not be installed on helical threading or knurling that provides a path for fuel leakage.

24.11.4 Clamps depending solely on the spring tension of the metal shall not be used.

24.11.5 Clamps shall be installed to impinge directly on the hose and shall not overlap each other.

24.11.6 Clamps shall be beyond the flare or bead, or fully on serrations where provided, and at least 1/4 inch (6mm) from the end of the hose.

24.11.7 Hose used in the fuel tank fill system shall be secured to pipes (smooth pipes acceptable), spuds or other fittings at each connection, by at least two metallic clamps with nominal band widths of at least 1/2 inch (12mm).

24.11.8 Hose used in the fuel tank vent system or the fuel distribution and return line system shall be secured to a mating spud, pipe, or fitting that is formed or machined to provide serrations [at least 0.015 inch (0.38mm) depth] or a bead. At least one corrosion resistant metallic clamp shall be used with a minimum nominal band width as indicated in Table III.

24.12 ***FUEL FILL SYSTEMS***

24.12.1 Separation between compartment ventilation openings and fuel fill openings shall be at least 15 inches (381mm).

24.12.2 Deck plates shall carry a permanent fuel type identification, e.g. GAS, GASOLINE, or the ISO symbol.

24.12.3 The minimum inside diameter of the fill system shall be 1 1/4 inch (31.75mm).

NOTE: To maintain the minimum diameter, using standard fittings, the minimum hose ID will be 1 ½ inch (38.1 mm).

24.12.4 Fuel fill lines shall be hose or metal pipe.

24.12.4.1 Flexible fuel fill hose installed in engine compartments shall be USCG Type A1 or A2. See Table I.

24.12.4.2 Fill hose installed outside of engine compartments shall be any of the hose types specified in 24.6.

24.12.5 Fuel fill lines shall be self-draining and run as directly as practicable from the deck plate to the fuel tank connection.

24.12.6 All components of the fuel fill system shall be accessible.

24.13 ***TANK VENT SYSTEMS***

24.13.1 The fuel vent system shall be designed to prevent spilling liquid fuel into the boat or the environment while fueling the boat in accordance with the boat manufacturer's instructions.

NOTE: There may be EPA or state regulations that limit the discharge of hydrocarbon emissions into the atmosphere from gasoline fuel systems. The latest versions of these regulations should be consulted.

24.13.2 Minimum inside diameter of vent line shall be 7/16 inch (11.11mm).

NOTE: To maintain the minimum diameter, using standard fittings, the minimum hose ID will be 9/16 inch (14.29mm).

24.13.3 Vent system shall have a flame arrester that can be cleaned unless the vent system itself is a flame arrester.

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NOTE: Vent fittings that are removable are considered cleanable.

24.13.4 Fuel vent lines shall be metallic or hose.

24.13.4.1 Flexible tank vent hose installed in engine compartments shall be USCG Type A1 or A2. See Table I.

24.13.4.2 Tank vent hose installed outside of engine compartments shall be any of the hose types specified in 24.6.

24.13.5 Separation between compartment ventilation openings and fuel tank vent line termination shall be at least 15 inches (381mm).

24.13.5.1 The tank vent shall have provision to minimize the intake of water without restricting the continuous release of vapor.

24.13.6 Tank vent systems shall be self-draining and connect to the highest point of the fuel tank as installed in the boat under conditions of normal operation and normal trim.

NOTE: In sailing auxiliaries, it may be necessary to have dual vents, each equal in size to the specification in 24.13.2.

24.13.7 All components of the tank vent system shall be accessible.

24.14 ***FUEL DISTRIBUTION AND RETURN SYSTEMS***

24.14.1 All components of the fuel distribution and return system shall be accessible.

24.14.2 Fuel distribution and return lines shall be seamless copper, nickel copper, or copper nickel with a minimum wall thickness of .029 inches (0.74mm) [nominal .032 inches (0.8mm)], or flexible fuel hose identified as USCG Type A1 (see Table I) if;

24.14.2.1 the line is within an engine compartment, or

24.14.2.2 a break at any point in the line will result in discharge of more than 5 ounces (150cc) of fuel in 2½ minutes including fuel that may drain from the engine, or

24.14.2.3 the line is between a remote fuel pump outlet and the engine fuel inlet, or

24.14.2.4 the line is for returning excess fuel to the fuel tank.

24.14.3 All other fuel distribution and return lines shall be of the type specified in 24.14.2, or USCG Type B1 hose. See Table I.

24.14.4 All individual components of the fuel system, as installed in the boat, shall be capable of withstanding a 2½ minute exposure to free burning fuel (N-Heptane) without leaking in accordance with the requirements of 24.5.7.

24.14.5 Metal fuel distribution and return lines secured to hull members shall be connected to the engine by a flexible section. The rigid metal line shall be supported within 4 inches (102mm) of this connection.

24.14.6 Fuel systems shall be equipped with an independently supported fuel strainer complying with 24.9, if a strainer is not incorporated in the pickup tube.

24.14.7 Fuel filters shall be independently supported on the engine or boat structure.

24.14.8 Electric fuel pumps, if used, shall be independently supported and located within 12 inches (305mm) of the engine with a maximum delivery hose length of 48 inches (1.22m).

24.14.8.1 Electrically operated fuel pump systems shall be connected to be energized only when the engine ignition switch is on and the engine is running. A momentary type override is acceptable for starting.

24.14.8.2 The outlet pressure of electrically operated fuel pumps shall be rated or controlled to the maximum carburetor fuel inlet pressure specified by the engine manufacturer.

EXCEPTION: Electric fuel pumps used to transfer fuel between tanks.

24.14.9 On vessels with multiple fuel tanks and a fuel system, such as fuel injection, that returns unused fuel to the tank, the system

24.14.9.1 shall return unused fuel to the same tank from which it was drawn, and

24.14.9.2 valves, or other means, shall ensure simultaneous switching of the fuel supply and return lines by a single operation to prevent fuel overflow.

24.14.9.3 Information about the design, operation, and maintenance of this system shall be provided in the vessel's owner's manual, and

24.14.9.3.1 this information shall include a warning about the consequences of modifying this system that may result in a fuel overflow. See ABYC T-24, *Owner's Manuals.*

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24.14.10 Fuel distribution systems shall be provided with anti-siphon protection by at least one of the following:

24.14.10.1 Keeping all parts of fuel distribution and return lines above the level of the tank top from the tank to the carburetor inlet or its equivalent, e.g., throttle body, port fuel injection, or a location where fuel leakage cannot enter the boat when the boat is in its static floating position;

24.14.10.2 installing an anti-siphon device at the tank withdrawal fitting, or along the line, with a rated siphon protection head and flow rate greater than required for the installation;

24.14.10.3 installing an electrically operated valve at the tank withdrawal fitting, or along the line, connected to be energized open only when the engine ignition switch is on and the engine is running;

NOTE to 24.14.10.3: A momentary type override is acceptable for starting.

24.14.10.4 installing a manual shut-off valve directly at the fuel tank connection, arranged to be readily accessible for operation from outside the compartment if the fuel tank top is located below the level of the carburetor inlet and the fuel line is rigid metal or USCG Type A1 hose.

24.14.10.4.1 If the length of fuel line from the tank outlet to the engine inlet is greater than 12 feet (3.6m), a second manual shut-off valve shall be installed at the fuel inlet connection to the engine.

NOTE: "Readily accessible from outside the compartment" includes a shut-off valve installed at the tank close to, and directly below, an access port in the deck through which the valve can be operated.

24.14.11 In outboard powered boats with permanently installed fuel tanks, the fuel distribution system shall be installed by the boat manufacturer.

24.14.11.1 Fuel distribution lines provided with anti-siphon protection shall be installed in outboard powered boats equipped with permanent tanks, and

24.14.11.1.1 fuel line connections to the engine shall terminate at the stern where fuel spillage will not enter the boat.

24.14.11.2 Quick disconnect fittings used between fuel distribution lines and outboard motors shall automatically shut off fuel flow when disconnected.

24.15 ***FUEL SYSTEM GROUNDING***

24.15.1 Each metal or metallic plated component of the fuel fill system and fuel tank, that is in contact with the fuel, must be grounded so that its resistance to the boat's ground is less than one ohm.

24.15.1.1 Wire ends shall not be clamped between the fill pipes and hose.

24.16 ***FUEL SYSTEM LABELING***

24.16.1 A warning label shall be placed in a readily visible location on the boat, or at a point of frequent servicing of the boat, and

24.16.1.1 the label shall comply with ABYC T-5, *Safety, Signs and Labels,* and shall contain at least the following informational elements:

1. the hazard intensity signal word;
2. nature of the hazard;
3. consequences that can result if the instructions to avoid the hazard are not followed;
4. instructions on how to avoid the hazard.

NOTE: An example of such a label follows:

⚠ WARNING

AVOID SERIOUS INJURY OR DEATH
FROM FIRE OR EXPLOSION
RESULTING FROM LEAKING FUEL.
INSPECT SYSTEM FOR LEAKS
AT LEAST ONCE A YEAR.

24.16.2 In systems with multiple engines, and/or multiple tanks, the valves in the system shall have a label that indicates what the valve is controlling, and what each valve position means, and

24.16.2.1 valves at junctions in the fuel system shall be labeled as to function and position.

24.17 ***INSTALLATION TESTS***

24.17.1 There must be no blow back of fuel through the fill fitting when filling at a rate of 9 gpm (34 lpm) from 1/4 to 3/4 of the capacity on the tank label. For fuel tanks of 25 gallons (95 liters) capacity or less, the fill rate may be reduced to 6 gpm (23lpm).

NOTE: A test to determine compliance with this requirement may be performed on a representative installation.

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24.17.2 Fuel fills shall be located and oriented so that no fuel can enter the boat when it is in its static floating position, and fuel overflows at a rate of 5 gpm (19 lpm) for 5 seconds.

24.17.3 Overflow from the fuel tank vent at the rate of 2 gpm (7.5 lpm) or less shall not enter the boat.

24.17.4 After installation, the fuel system of every boat shall be pressure checked to at least 3 psi (21kPa), or at 1 ½ times the maximum hydrostatic head to which it may be subjected in service, whichever is greater.

24.17.4.1 The fuel system shall evidence no leakage under such testing, checked at a minimum of 5 minutes after application of the test pressure, for systems of 50 gallons (190 liters) or less capacity, with one additional minute for each increment of 10 gallons (38 liters), or fraction thereof, above 50 gallons (190 liters).

24.17.4.2 A leak detection method other than the pressure drop method must be used at every joint except at the deck fill and exterior vent fittings.

NOTE: It is suggested that soapy test solutions be non-corrosive and non-toxic. Ammonia, present in some soaps and detergents, creates a condition that attacks brass fittings like those used in fuel systems. Undetectable at first, in a matter of months these fittings may develop cracks creating a very hazardous situation.

24.18 ***GASOLINE FUEL TANKS***

24.18.1 Tank Materials

24.18.1.1 Material thickness shall be at least the minimum thickness listed in TABLE IV .

24.18.1.1.1 Materials not listed in TABLE IV shall be tested to demonstrate corrosion resistance in a marine environment equivalent to those materials listed.

24.18.1.2 Steel sheet tanks, when constructed for gasoline shall be galvanized on the inside and out by the hot dip process.

24.18.1.3 Fuel tanks shall not be constructed of terneplate steel.

24.18.1.4 Non-metallic materials are considered acceptable for corrosion resistance; however, all other requirements of this standard must be met.

24.18.1.5 The copper base alloys normally used for fuel fittings and lines are considered acceptable for direct coupling with all fuel tank materials listed in TABLE IV , except aluminum.

24.18.1.6 Copper-base alloy components shall be separated from contact with aluminum tanks or fitting plates by means of a galvanic barrier such as 300 series stainless steel.

24.18.1.7 Fastenings used to couple fittings, such as fuel senders, to aluminum tanks shall be of 300 series stainless steel or its equivalent in corrosion resistance.

24.18.2 Design and Construction

24.18.2.1 Fuel tanks shall not be integral with the hull.

24.18.2.2 Stainless steel tanks shall be cylindrical, with domed heads, and a capacity of less than 20 gallons (75 liters).

24.18.2.3 Each opening into the fuel tank shall be at or above the topmost surface of the tank.

24.18.2.4 The tank design shall be such that no exterior metallic part of the tank will trap water as the tank is intended to be installed when the boat is in the static floating position.

24.18.2.5 The exterior shape of the tank(s) shall provide smooth bearing surfaces to support and secure the tank(s).

24.18.2.6 Spuds and other tank fittings shall be attached so as to maintain the liquid and vapor tight integrity of the tank without reducing the strength of the tank wall.

24.18.2.7 If baffles are provided, the total open area provided in the baffles shall be a maximum of 30 percent of the tank cross section in the plane of the baffle.

24.18.2.7.1 Baffle openings shall be designed so that they do not prevent the fuel flow across the bottom or trap vapor across the top of the tank.

24.18.2.8 Threaded connections into fuel tanks shall be in accordance with the American Standard Taper Pipe Thread (NPTF), and shall provide for thread engagement in accordance with TABLE V.

24.18.2.9 Rigid fuel pick-up tubes and fill pipes that extend near the tank bottom shall have clearance to prevent contact with the bottom due to flexing of the tank.

24.18.2.10 If a pick-up tube is equipped with a fuel strainer, it shall:

24.18.2.10.1 permit water contamination to be withdrawn from the tank with the fuel;

24.18.2.10.2 have a micron rating of 500 minimum, 600 maximum;

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24.18.2.10.3 be resistant to salt, water, alcohol and stale gasoline; and

24.18.2.10.4 be accessible for servicing.

24.18.2.11 If the fuel pick-up tube is not furnished as part of the tank, the tank manufacturer shall provide a detailed construction print of the tank and the pick-up tube installation.

24.18.2.12 The fuel return line terminus shall be above the level of the fuel when the tank is filled to its rated capacity.

24.18.2.13 Fuel tanks shall be designed to withstand the applicable tests indicated in 24.18.4 and 24.18.5.

NOTE: Fuel tanks meeting the requirements of ANSI/UL 1102, Non-integral Marine Fuel Tanks, comply with these requirements of 24.18.2 through 24.18.2.13.

24.18.3 Tank Labels

24.18.3.1 All fuel tanks shall bear a label with at least the following information:

24.18.3.1.1 manufacturer's name, or trademark, and address;

24.18.3.1.2 month, or lot number, and year of manufacture;

24.18.3.1.3 capacity in US gallons/liters;

24.18.3.1.4 material specification and thickness;

24.18.3.1.5 fuel for which tank is suitable;

24.18.3.1.6 maximum test pressure;

24.18.3.1.7 model designation, and

24.18.3.1.8 the statement, "This tank has been tested under Title 33 CFR, Section 183.510(a)."

24.18.3.2 Each letter and each number on a label shall

24.18.3.2.1 be at least 1/16 inch (1.6mm) high, and

24.18.3.2.2 contrast with the basic color of the label or be embossed on the label.

24.18.3.3 Each label shall

24.18.3.3.1 withstand the combined effects of exposure to water, oil, sea spray, direct sun light, heat, cold, and wear expected in normal operation of the boat, without loss of legibility, and

24.18.3.3.2 resist efforts to remove or alter the information on the label, without leaving some obvious sign of such efforts.

24.18.4 Tank Fire Resistance Tests

24.18.4.1 Representative samples of the fuel tanks shall be subjected to the test described herein. The tank to be tested shall be a complete assembly and include the fuel pick-up tube, fuel fill pipe, and fuel gauge/sender specified for the fuel tank.

24.18.4.2 A single fuel tank design, shown to be representative of a series of fuel tanks of similar design, size, and construction, may be tested as representative of that series of fuel tanks.

24.18.4.3 A fuel tank shall be capable of withstanding exposure to a test fire without contributing to the fire due to leakage of the fuel contained therein.

NOTE: For the purpose of this test, slight vapor leakage will be permitted, except in the tank shell, if it can be shown that the path of leakage will not permit a fire outside the tank to ignite vapors within the tank.

24.18.4.4 The fuel tank sample to be tested shall be provided with all the attachments specified by the manufacturer.

24.18.4.5 As Installed Fire Test

24.18.4.5.1 This test shall be conducted to qualify fuel tanks intended to be installed in a particular model boat, or series of boats, where the construction of the tank is known and the installation of the tank is specified or otherwise controlled.

24.18.4.5.2 The fuel tank sample shall be installed in an actual or simulated hull section of sufficient size to simulate fire conditions aboard the boat. All bulkheads, supports, floors, and other surfaces in the simulated fuel tank compartment shall be of the same material, or of equivalent flammability, to that used on the boat.

24.18.4.5.3 To qualify a fuel tank intended for use in a series of boats, the fuel tank sample shall be installed in a simulated hull section providing the maximum fire exposure representative of that series of boats.

24.18.4.5.4 The fuel tank sample, and all connecting piping and fittings, shall be checked for leakage at an aerostatic pressure of 3 psi (21kPa) applied to the tank vent.

24.18.4.5.4.1 The size of the fuel tank sample vent shall be determined by the size of the vent fittings provided by the manufacturer.

24.18.4.5.5 Following the pressure test, the pressure shall be released and the tank vent left open to simulate a normal condition.

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24.18.4.5.6 The fuel tank sample shall be filled to one-quarter rated capacity with gasoline, and all openings capped or plugged, except for the fuel tank vent, that is to be extended without traps, outside the first test area.

24.18.4.5.7 N-Heptane shall be poured into all crevices and liquid traps in which fuel could collect in the boat, assuming a leak anywhere in the fuel system. If possible, the amount of fuel in each liquid trap shall be sufficient to burn for a period of 2½ minutes.

24.18.4.5.8 The test method described in 24.18.4.7 shall be used.

24.18.4.6 General Installation Fire Test

24.18.4.6.1 This test shall be conducted to qualify fuel tanks where the actual installation conditions are not known.

24.18.4.6.2 The fuel tank sample is to be supported in a test enclosure, as shown by Figure 1, if the fuel tank is intended for below-deck installation, or in a test enclosure, as shown in Figure 2, if the tank is intended for above-deck installation.

24.18.4.6.3 The side supports of the fuel tank sample are to be spaced to support the fuel tank ends, and at each fuel tank baffle, and are to be formed to maintain the fuel tank sample 2 inches (50.8mm) away from the inside surface of the simulated hull side panel.

24.18.4.6.4 The supports for the bottom of the fuel tank sample are to be located in the same manner as the side supports, and are to be formed to maintain the fuel tank sample 3 inches (76.2mm) above the inside surface of the enclosure.

24.18.4.6.5 The fuel tank sample is to be secured to the test enclosure by steel straps. The top of the test enclosure shall be formed so that the maximum fuel tank's sample set-back does not exceed 2 inches (50.8mm) and the clearance between the top of the test enclosure and the top of the fuel tank sample is not less than 7 inches (177.8mm), nor more than 34 inches (863.6mm).

24.18.4.6.6 The area of the enclosure beneath the fuel tank sample is to serve as the fuel reservoir, and shall be formed so that the surface of the test fuel extends 6 inches (152.4mm) beyond the fuel tank sample ends, and 2 inches (50.8mm) beyond the exposed front surface of the fuel tank sample. The reservoir shall be made leak proof, and shall be capable of containing sufficient fuel to burn for a period of 2 ½ minutes.

24.18.4.6.7 The fuel tank sample, and all connecting piping and fittings, shall be checked for leakage, and 3 psi aerostatic pressure applied to the tank vent. Following the Pressure Test, the pressure shall be released, and the tank vent left open to simulate a normal condition. The size of the fuel tank sample vent shall be determined by the size of the vent fitting provided by the manufacturer.

24.18.4.6.8 The fuel tank sample is to be filled to one-quarter rated capacity with gasoline, and all openings capped or plugged, except for the fuel tank vent that is to be extended without traps, outside the Fire Test areas.

24.18.4.6.9 N-Heptane shall be poured into the reservoir in accordance with 24.18.4.5.7.

24.18.4.6.10 The test method described in 24.18.4.7 shall be used.

24.18.4.7 Test Method for Fuel Tank Fire Test

24.18.4.7.1 The area in which the test is to be conducted is to be free from drafts, but shall have provision for a free inflow of air during the test. The test shall be conducted as follows.

24.18.4.7.2 The N-Heptane in the hull section or the test enclosure shall be ignited and permitted to burn for a continuous period of 2½ minutes. The temperature within one inch of the component must be at least 1200°F (648°C) some time within the 2½ minute test.

24.18.4.7.3 At the end of the 2½ minute test period, any continued burning is to be extinguished.

24.18.4.7.4 Following the test, the fuel tank sample shall be examined for leakage and then drained, and pressure-checked with 1/4 psi (1.75kPa) of aerostatic pressure. This pressure shall be applied gradually by means of a suitable regulator so as not to strain the tank due to pressure surge. The tank fails the test if leakage is detected in the tank shell using a means other than the pressure drop method.

24.18.5 Tank Mechanical Strength Tests

24.18.5.1 Static Pressure Test - Representative samples of the fuel tanks shall be tested by the tank manufacturer at 1½ times the maximum test pressure indicated on the tank label, with gauge or sending unit installed. See 24.18.3. The fuel tank shall not exhibit any leakage using a leak detection method other than the pressure drop method.

24.18.5.2 Shock Test - Representative samples for fuel tanks of less than 25 gallons (95 liters) capacity shall not leak, or show signs of permanent deformation, or other signs of failure following 1000 cycles of vertical shocks with an acceleration of 25g with a duration measured at the base of the shock envelope of 6-14 milliseconds.

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24.18.5.2.1 Shock tests for non-metallic fuel tanks shall be conducted on the fuel tank samples that have contained ASTM Reference Fuel C for 30 days at room temperature 70°F - 80°F (21.1°C - 26.7°C).

24.18.5.2.2 The fuel tank sample filled to capacity with water shall be mounted to a platform using supports, chocks or hangers either furnished with the tank or intended to be used in a boat installation.

24.18.5.2.3 The platform shall be connected to a device that will repeatedly raise and drop the platform at a rate not to exceed 80 impacts per minute. By varying the height of the drop and/or cushioning under the platform the top surface of the platform shall be calibrated as close to the tank center of gravity as is practicable to provide the specified shock impacts.

24.18.5.2.4 The tank shall be tested to meet the requirements of 24.18.5.1.

24.18.5.3 Pressure-Impulse Test - Representative samples of 25 gallons (95 liters) capacity and more shall not leak or show signs of permanent deformation or other signs of failure following 25,000 cycles of pressure-impulse.

24.18.5.3.1 Pressure-Impulse tests for non-metallic fuel tanks shall be conducted on the fuel tank samples that have contained ASTM Reference Fuel C for 30 days at room temperature 70°F - 80°F (21.1°C - 26.7°C).

24.18.5.3.2 The fuel tank sample filled to capacity with water shall be mounted using support, chocks, or hangers, either furnished with the tank, or intended to be used in a boat installation.

24.18.5.3.3 The fuel tank sample is to be attached to a regulated source of pressure of either air, nitrogen, or water. The control mechanism of the pressure source is then to be set to cause the pressure in the sample, measured at its top-most surface, to vary from 0 to 3 to 0 psig (0 to 21 to 0 kPa) at a rate of not more than 15 cycles per minute.

24.18.5.3.4 The fuel tank shall be tested to, and meet the requirements of 24.18.5.1.

24.18.5.4 Slosh Test - Representative samples of fuel tanks of 200 gallon (755 liters) capacity and more shall not leak, or show signs of permanent deformation, or other signs of failure, following 500,000 cycles of rocking motion. This test shall be performed following the Pressure Impulse Test on the same fuel tank sample.

24.18.5.4.1 Slosh tests for non-metallic fuel tanks shall be conducted on the fuel tank samples that have contained ASTM Reference Fuel C for 30 days at room temperature 70°F - 80°F (21.1°C - 26.7°C).

24.18.5.4.2 The fuel tank sample used for this test is to be provided with all attachments specified by the manufacturer.

24.18.5.4.3 The fuel tank sample is to be centered on a rocker assembly to simulate the recommended tank installation using supports, chocks, or hangers, either furnished with the tank, or intended to be used in a boat installation.

24.18.5.4.4 The fuel tank sample is to be filled with dye-colored water to one-half its rated capacity, and all fuel tank fittings, except the tank vent, are to be capped.

24.18.5.4.5 The rocker assembly shall be adjusted to produce a rocking motion of approximately 15 degrees, to either side of a vertical reference line, at a rate of 3 to 4 seconds per cycle.

24.18.5.4.6 The axis of rotation of the rocker and fuel tank sample shall be parallel to the tank baffles and perpendicular to the centerline of the tank length at a level not more than 6 inches (152.4mm) above or below the tank bottom.

24.18.5.4.7 The tank shall be tested to, and meet the requirements of 24.18.5.1.

24.18.5.5 Tank Pressure Tests - Every tank shall be tested by its manufacturer prior to installation to the maximum test pressure indicated on the tank label without evidence of leakage. The test pressure shall be not less than 3 psig (21kPa).

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TABLE I - TYPES OF HOSE

HOSE MARKING	PERMEATION RATING	2 1/2 MINUTE FIRE TEST
USCG TYPE A1	100 g/m^2/24 hrs.	required
USCG TYPE A2	300 g/m^2/24 hrs.	required
USCG TYPE B1	100 g/m^2/24 hrs.	not required
USCG TYPE B2	300 g/m^2/24 hrs.	not required

TABLE II - MATING OF HOSE WITH SPUDS

IF MINOR OD IS:	MAXIMUM DIFFERENCE IN DIAMETER IS:
Inches (Millimeters)	Inches (Millimeters)
Less than 3/8 (9.53)	0.020 (0.508)
3/8 (9.53) thru 1 (25.4)	0.035 (0.889)
Greater than 1 (25.4)	0.065 (1.651)

TABLE III - HOSE CLAMP WIDTHS

MINIMUM NOMINAL CLAMP BAND WIDTH

OUTSIDE HOSE DIAMETER	MINIMUM CLAMP BAND WIDTH
Inches (Millimeters)	Inches (Millimeters)
Less than 7/16 (11.11)	1/4 (6)
7/16 (11.11) thru 13/16 (20.64)	5/16 (8)
Over 13/16 (20.64)	3/8 (10)

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TABLE IV - METALLIC FUEL TANK MATERIAL AND FABRICATION REQUIREMENTS FOR CORROSION RESISTANCE

MATERIAL (See Note 1)	SPECIFICATION	MINIMUM NOMINAL SHEET THICKNESS	GAUGE
Nickel-Copper	ASTM-B127 Class A	.031 in. (.79mm)	22 US std.
Copper-Nickel	ASTM-B122	.045 in. (1.14mm)	17 A.W.G.
Copper	ASTM-B152 Type E.T.P.	.057 in. (1.45mm)	15 A.W.G.
Copper-Silicon	ASTM-B97 Types A, B & G	.050 in. (1.27mm)	16 A.W.G.
Steel Sheet	ASTM-A93	.0747 in. (1.90mm)	14 Mfrs.
Aluminized Steel	ASTM A-463	.0478 in. (1.21mm)	18 Mfrs.
Aluminum	Alloy 5052 or 5083 or 5086	.090 in. (2.29mm)	----------
Stainless Steel	316L or 317L	.031 in (.79mm) (See Note 2)	22 US std. (See Note 2)

NOTES: 1. See American Welding Society recommendations for welding processes.

2. Only cylindrical stainless steel tanks with domed heads and a capacity of less than 20 gallons are permitted.

TABLE V - TAPERED PIPE THREAD ENGAGEMENT

NOMINAL PIPE SIZE	MINIMUM THREAD ENGAGEMENT (Inches) See Note.
1/8	.162
1/4	.228
3/8	.240
1/2	.320
3/4	.339
1	.400
1 1/4	.420
1 1/2	.420
2	.436

NOTE: The minimum lengths of thread engagement are those that can normally be achieved by hand, when assembling a male and female pipe thread together. Additional tightening is necessary to make a joint that will not leak.

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FIGURE 1 ENCLOSURE - BELOW DECK INSTALLATION

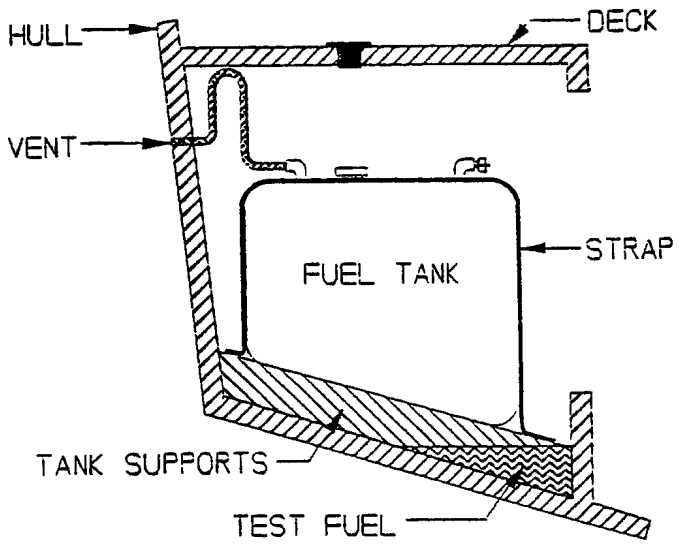
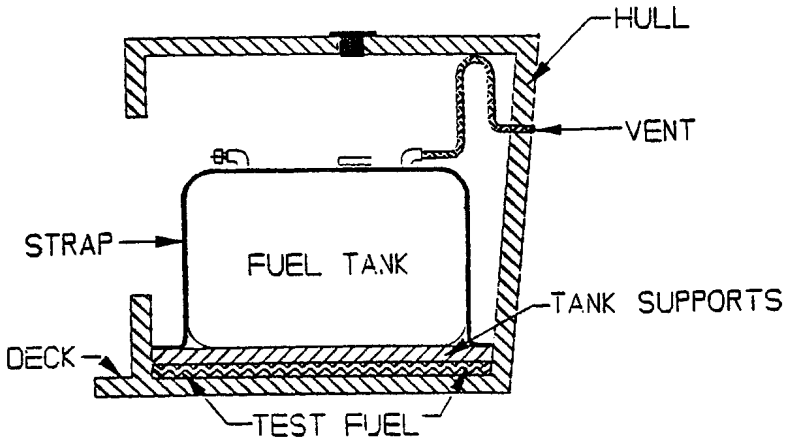


FIGURE 2 ENCLOSURE - ABOVE DECK INSTALLATION



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APPENDIX A - MARINE FUEL SYSTEM COMPONENT FIRE TEST

Ap.1 Method

Ap.1.1 Conduct the test in a fire test chamber in a draft-free area.

Ap.1.2 Connect the sample to a system of full size fuel piping, complete with a fuel supply tank and the valves, as shown in Figure 1.

Ap.1.3 Center and position the sample vertically 8 to 10 inches above the liquid surface of a pan of sufficient size, both to extend beyond the entire horizontal area of the sample, and to accommodate enough N-heptane to burn continuously for at least 2-1/2 minutes.

Ap.1.4 Charge the tank and the remainder of the system with N-heptane.

Ap.1.5 Position two thermocouples in the same horizontal plane as the sample, one-half inch away from the sample surface, with the tips of the thermocouples positioned 1" (25.4 mm) from the end of each fitting of the sample, and 10" (254 mm) above the surface of the fuel level.

Ap.1.6 The supply tank valve will then be opened and the system bled of all air by allowing fuel to flow through the system from the tank through the open discharge valve.

Ap.1.7 With the system full of fuel, shut off the discharge valve. Ignite the pan of fuel and allow it to burn for 2-1/2 minutes.

Ap.1.8 During the burning, record temperatures at intervals not to exceed 15 seconds.

NOTES: If the temperatures measured by one or both thermocouples do not reach 1200°F (648°C) at some time during the 2 ½ minute time period, then the test shall be repeated with a new sample.

Ap.1.9 At the end of the 2 ½ minutes, extinguish the fire by fully discharging a ten pound carbon dioxide extinguisher.

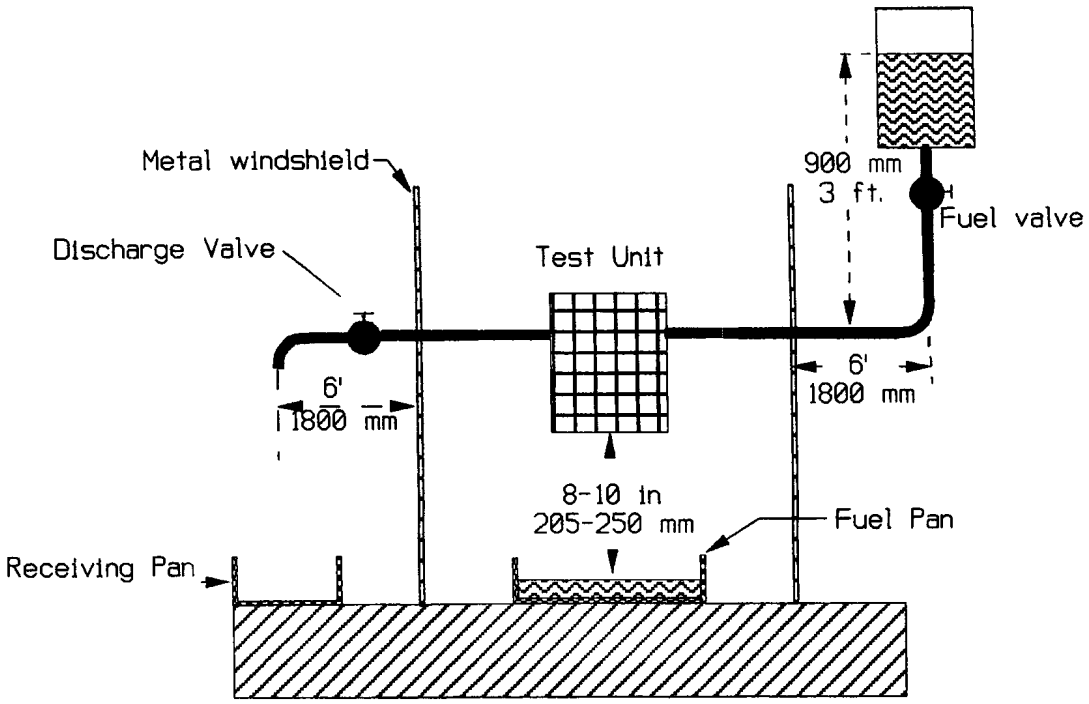
Ap.1.9.1 The fuel lines and the sample shall not be disturbed.

Ap.1.10 Immediately after the fire is extinguished, the discharge valve shall be opened and fuel allowed to run through the system until a steady stream is obtained.

Ap.1.11 Then close the discharge valve, place the system under a hydrostatic pressure of three feet of head, and monitor the sample for leakage for a period of five minutes.

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Ap.A FIGURE 1 - FUEL SYSTEM COMPONENT FIRE TEST APPARATUS



Fuel System Component Fire Test
Test Apparatus

* * * * *

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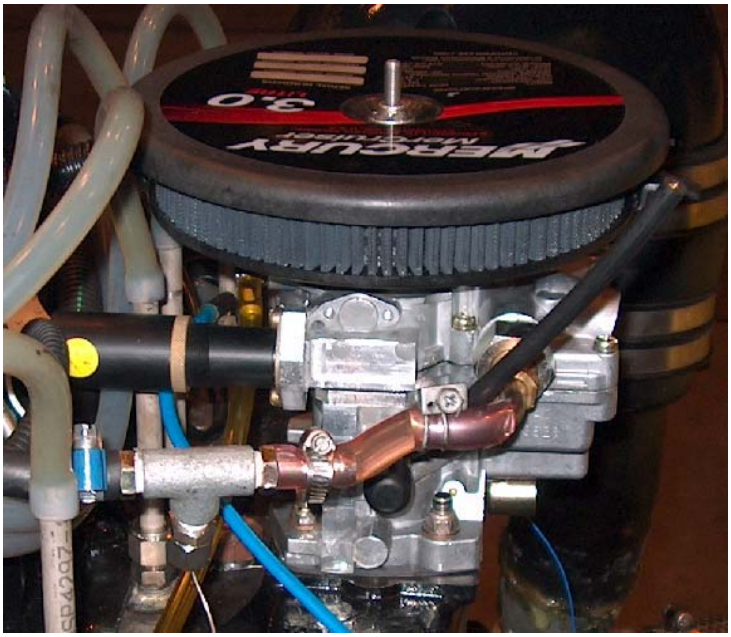
Notes:

Turn Key Start (TKS) System

- This system will be installed on all carbureted engines. Production start will be during August through October of 2004.

- **Basic Design:**

  - Additional fuel is required during engine starting and warm up.
  - The new design began with the current casting and components similar to carbureted outboard.
  - The casting was modified adding an additional fuel flow path for the TKS module.
  - The TKS flow path is normally open and closes using a heat expanding device coupled to a needle/seat. This device closes the additional fuel flow path after receiving 12 Vdc for 6-10 minutes.
  - The engine will run at an elevated RPM (900 – 1,000) for the 6-10 minutes and then return to the normal idle speed.



Carburetor with TKS

- **Operation:**

  - The new carburetor operates in a manner very similar to the previous MerCarb units, but now has the added benefit of having an additional amount of fuel automatically provided to the engine during cold starts. Pumping the throttle twice before starting the engine is no longer necessary. You just turn the key to start the engine.

- TKS fuel path is in the normally open position. Electric power causes a wax expanding device to expand thus causing the needle to meet the seat and close the additional TKS fuel path.

- **Electric Paths:**

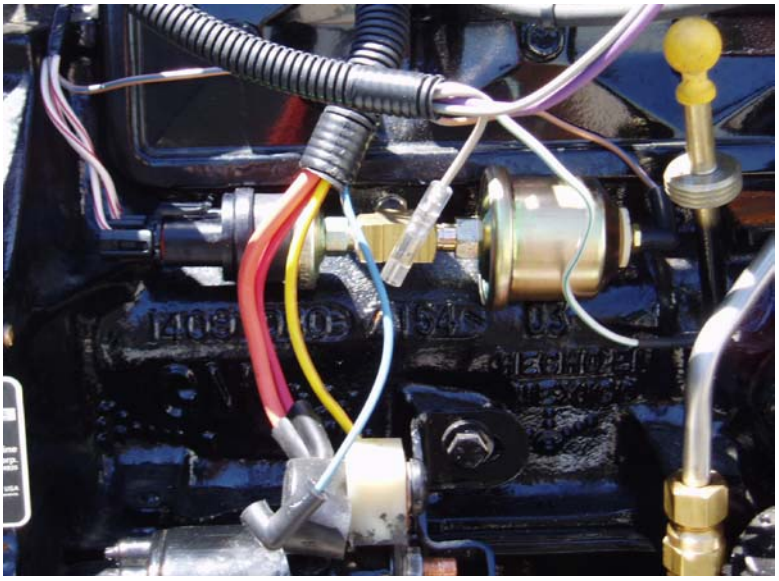
  - There are two paths for electricity to get to the module: one via an additional oil pressure switch and one via an additional engine coolant switch.

  - Additional Oil Pressure Switch:

    An oil pressure switch is added to the system using a “T” fitting. One lead is wired into the purple wire in the harness, the other to the TKS unit.

    When oil pressure exceeds 4psi (i.e. engine running) the oil pressure switch closes sending power to the TKS unit. This begins heating the element and causing closure within 6-10 minutes.

    Power will continue to flow to the TKS unit as long as there is power on the purple wire and there is oil pressure. Thus, if the key is left in the run position, with the engine not running, the TKS unit will not receive power.



Oil Pressure Switch

- Additional Coolant Temperature Switch:

A second switch has been added to the system and it is located in a new thermostat housing on the 3.0L models and in the intake manifold coolant passage on V6 and Small Block V8 models.

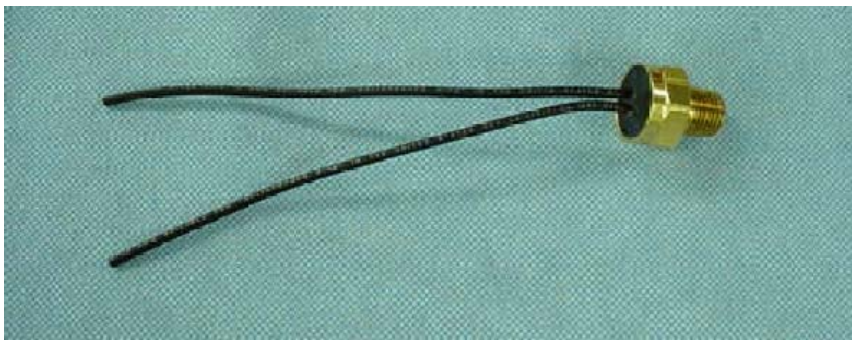
This switch is used to keep the TKS unit from opening (when the engine is warm), which prevents additional fuel from entering the engine under hot re-start conditions.

One lead is wired to the circuit breaker (i.e. battery power via an in-line fuse) and the other lead is wired to the TKS unit. This switch is normally open and closes (completing the circuit) above 130 degrees F.

When the engine coolant temperature reaches 130 degrees F, the coolant temperature switch closes and remains closed until the coolant (or sea water on sea/raw water cooled engines) temperature drops below 110 degrees F. When closed, the switch sends 12Vdc to the TKS Module, thus keeping the additional fuel flow path closed until the engine cools sufficiently to warrant the additional starting fuel.

Once the coolant temperature drops below 110 deg F. the coolant temperature switch opens and the 12Vdc is no longer sent to the TKS module. The TKS unit will cool allowing the needle to back off the seat and aid in the next starting event.

The wiring harness will be equipped with a diode to prevent power from this source running back on the purple lead, which would keep the engine running after a commanded stop.



Coolant Temperature Switch

- **Troubleshooting and Repair:**

  - The TKS system has very few repair parts:

    The TKS Module
    The oil pressure switch
    The coolant temperature switch and diode



TKS Module

- There are essentially three failure modes:

Hard Starting – Cold

In this mode, the TKS fuel path is closed. As the module is normally open, there are 3 possible root causes:

- Continuous power is getting to the TKS module
- Debris in the TKS fuel path
- The TKS module has failed

Hard Starting – Hot

In this mode, the TKS fuel path is open. As the module is normally open, there are two possible root causes:

- Continuous power is not getting to the TKS module
- The TKS module has failed

Poor running/running rich/excessive fuel consumption

- In this mode, the TKS fuel path is open and the causes are the same as Hard Starting – Hot.

- **TKS Retro Fit Kit**

  - Retro Fit Kits will be available for all engine lines, at the end of the year (2004):

    3.0 L 1996 – 2004
    4.3 L 1998 – 2004
    5.0 L 1998 – 2004
    5.7 L 1998 – 2004

  - Anti-Dieseling Kits are **not compatible** with TKS carburetors or Retro Fit Kits.

  - Each kit will come with some, or all of the components shown below (depending on engine model) that are necessary for installation:

    - TKS Carburetor w/ mounting gasket
    - Oil pressure switch with fittings
    - Coolant temperature switch with fittings
    - New thermostat housing
    - Engine harness jumper
    - Flexible fuel line
    - Installation Instructions

Service and Parts Bulletins

For subjects covered in the Fuel Delivery System and Carburetion Section

Service Bulletins

91-28 Required Water Separating Fuel Filter Replacement

92-5 Required Warning Decal Installation
92-15 Official Notification under the U.S. Federal Boat Safety Act – Required Fuel Pump RFI Filter Replacement

93-5 Required Fuel Pump Push Rod Replacement
93-15 Rochester 4 Barrel Quadrajet Carburetor

94-12 EFI Gasoline Recommendation Changes Number 1 and 2
94-15 Official Notification under the U.S. Federal Boat Safety Act – Required Engine Fuel Filter Replacement

97-8 MerCarb 2 Barrel Carburetor
97-9 Weber 4 Barrel Carburetor
97-17 Engine “Dieseling” and “Running-On”

98-4 Electric Fuel Pump Check Valve Sticking
98-5 USA Gasoline Additive Causing Fuel System Component Problems

99-7 Gasoline Engine Vapor Locking (Rev. 1/01)
99-8 EFI/MPI Fuel Pumps with Low Pressure

00-5 Official Notification under the U.S. Federal Boat Safety Act – Stainless Steel Fuel Pumps

01-4 Priming Fuel System
01-5 496/8.1 Fuel Line etc.

02-2 Inline Fuel Filter Kit
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04-01 Electric Fuel Pump Troubleshooting

Parts Bulletins

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FUEL SYSTEMS – LEVEL I

3

B

ELECTRONIC FUEL INJECTION – INTRODUCTION

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Speed / Density Theory and Operation

Speed/Density Theory

All MerCruiser EFI engines operate on the fuel injection strategy called “Speed/Density”. This means that the ECM primarily looks at the engine’s **speed** and the intake manifold’s air **density** in order to calculate the correct amount of fuel to inject.

The engine requires an air/fuel mixture of approximately 14:7 to 1 in the combustion chambers. Since the EFI system doesn’t control air flow, it must determine how much air is flowing through the engine in order to calculate the correct amount of time to fire the fuel injectors. The net result is that there must be 1 part of fuel for every 14.7 parts of air going through the engine.

Since the engine is basically an air pump, we know that an engine is capable of pumping a certain (maximum) amount of air at any specific rpm. The actual amount of air it pumps (at a specific rpm) depends on the density of the air in the intake manifold. The air density (in the intake manifold) will vary depending on rpm, throttle plate position and barometric pressure. If the air density in the intake manifold is known, the actual amount of air flowing through the engine (the “Air Mass” or “Mass Air Flow”) **could** be calculated. This calculated (and the actual) air flow is a repeatable function, meaning that at a specific rpm and a specific manifold absolute pressure reading, the air flow through the engine will always be the same.

However, in the speed/density system we do not actually calculate the actual air flow. Instead, the ECM measures the rpm and the air density, then refers to a programmed “lookup table” in the ECM’s EEPROM. This lookup table will be programmed with the correct fuel injector information for every rpm and density reading. The programming engineer has to come up with these figures, because the ECM is not actually calculating the Mass Air Flow.

The speed-density system depends on the engine being unmodified (from its original production state). If we change the volumetric efficiency of the engine in any manner, the amount of air flow for a given rpm and air density will change, causing the ECM to deliver the incorrect amount of fuel. Any modification to the following components will influence the air flow through the engine, throwing the speed-density system out of calibration.

1. Pistons and combustion chambers (anything that changes the compression ratio).
2. Camshaft changes (effecting the valve timing, lift and duration).
3. Changes to intake and exhaust valve size, as well as “porting and polishing”
4. Installing different intake and/or exhaust manifolds.
5. Installing a different size throttle body and/or flame arrestor.

Speed/Density Operation

The engine's RPM is easily determined from the REF HIGH signal on systems with EST ignition, or the timing signal from the Thunderbolt Distributor's hall-effect sensor on small-block MEFI 3 models.

To determine the density of the air in the intake manifold, we need to know the intake manifold vacuum, which we measure with the MAP (Manifold Absolute Pressure) sensor. It is important to remember that a MAP sensor measures the manifold pressure **above** absolute zero (like a barometer), while a conventional vacuum gauge measures the manifold pressure **below** the **current** atmospheric pressure. The use of the Manifold Absolute Pressure Sensor allows us to compensate for variations in atmospheric pressure due to weather and altitude changes. A conventional vacuum gauge would not provide us with this needed information.

NOTE: *While the temperature of the air does affect its density, not all engines use an IAT (intake air temperature) sensor. If no IAT is present, then the ECM assumes 75 degree Fahrenheit for all density calculations. If an IAT is present, then the ECM can more accurately determine the air's density. However, the amount of correction the IAT adds is a relatively small amount (approximately 10% maximum change in fuel flow).*

In review, our standard, unmodified production engines flow a repeatable (and therefore "known") amount of air at any specific engine rpm and manifold pressure. With this knowledge, the ECM can be programmed to deliver the correct amount of fuel from the combination of the speed sensor (distributor signal) and density information (from the MAP sensor).

It is often said that the speed-density system runs "in theory alone", since the ECM doesn't really know how much air is flowing through the engine, it is just assuming it knows how much (based on the repeatability of airflow theory). In reality, the system is simple, rugged and works extremely well. But, the ECM cannot compensate for changes in volumetric efficiency of the engine.

How does the ECM get the Speed-Density data (input)?

The engine speed sensor is already available to the ECM. This information can come from the ignition distributor. The density sensor will have to be created and added to the engine. This sensor is called the Manifold Absolute Pressure Sensor or MAP sensor. It can be thought of as an electric barometer. A MAP sensor is different than a hand held vacuum gauge in that the vacuum gauge reads in inches of mercury **below** the current barometric pressure. A MAP sensor reads in inches of mercury **above** absolute zero (like a barometer) so that it can correct for day to day variations of the barometric pressure. An electrical signal will be sent from the MAP sensor to the ECM.

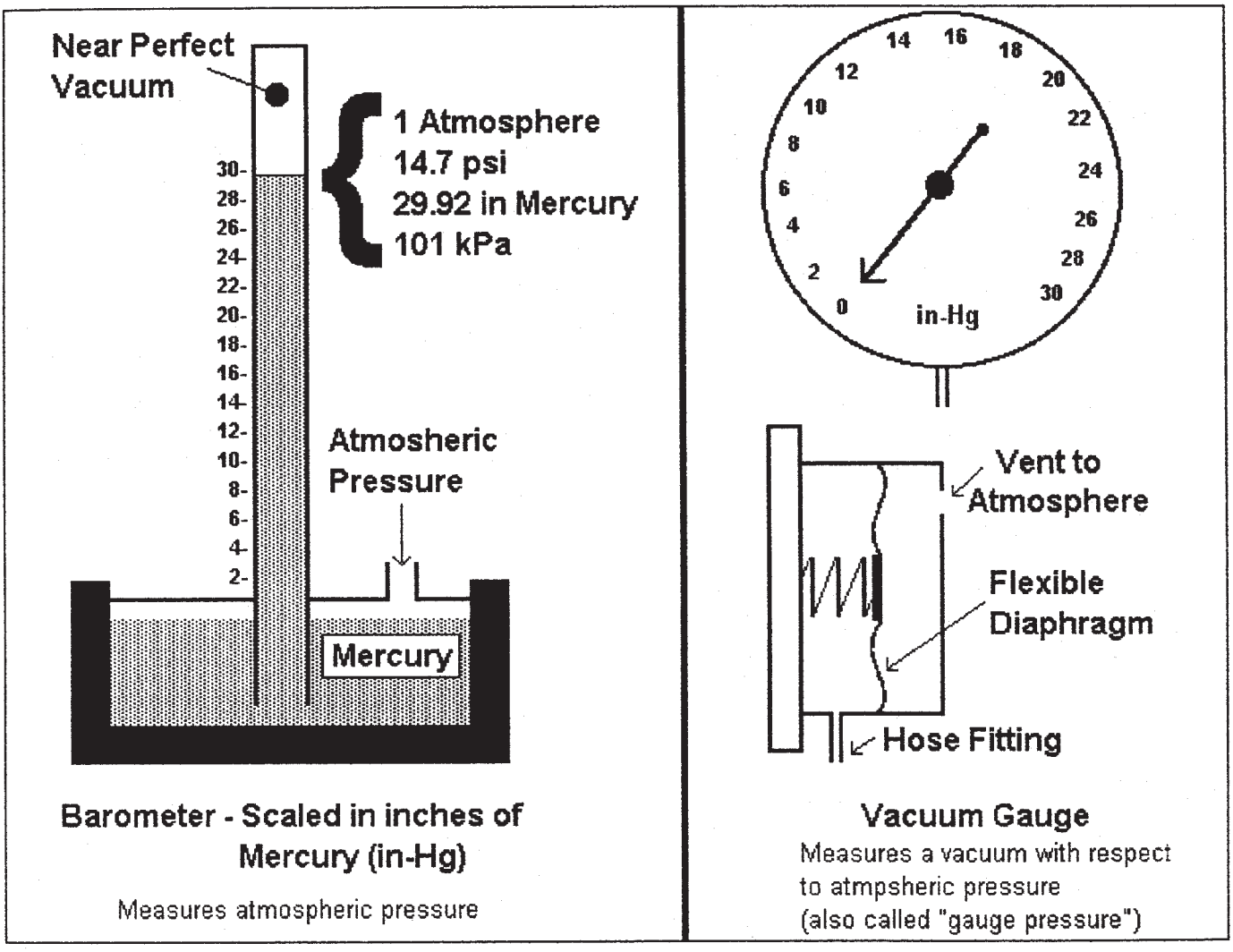
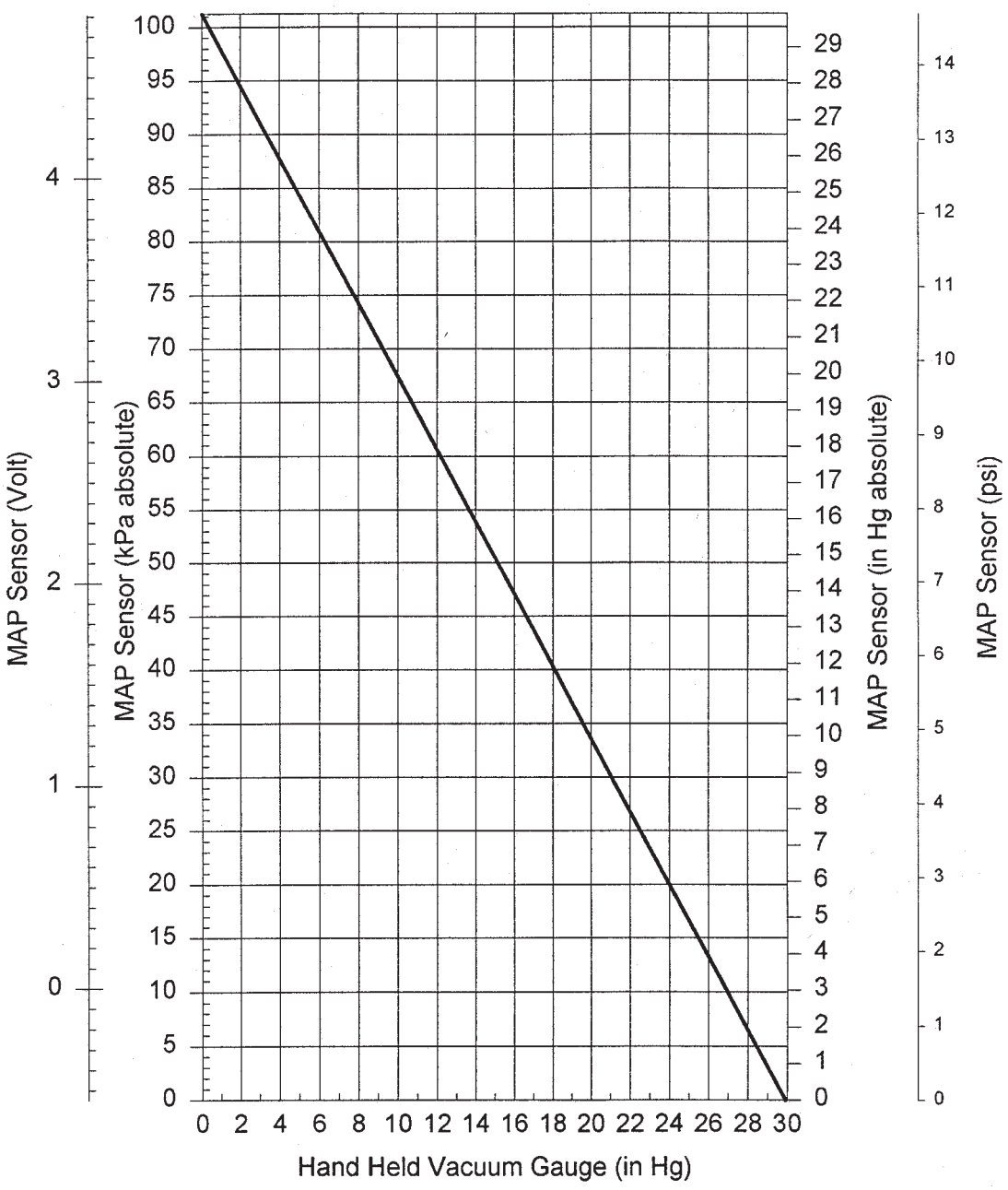


Figure 1 - ***Manifold Absolute Pressure = Barometric Pressure − Gauge Pressure***

VACUUM GAUGE VS MAP SENSOR


MAP Sensor (Volt)
MAP Sensor (kPa absolute)
MAP Sensor (in Hg absolute)
MAP Sensor (psi)
Hand Held Vacuum Gauge (in Hg)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

This graph is correct at Sea Level only.

EST Ignition – Source of “Ref Hi” Signal

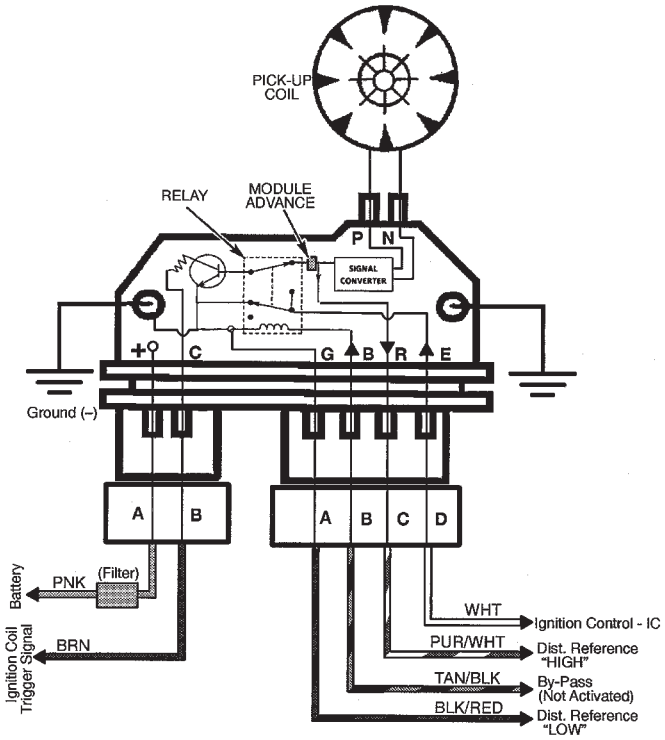
The Electronic Fuel Injection (EFI) is controlled by an Electronic Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The EFI system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The EFI system has been designed to control ignition advance and retard electronically by the ECM. This electronic advance becomes much more exact and reliable, just as EST is more exact and reliable when compared to the breaker point-ignition system.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the EST module which converts the pickup coil voltage to a square wave (digital) reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. The ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the EST module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

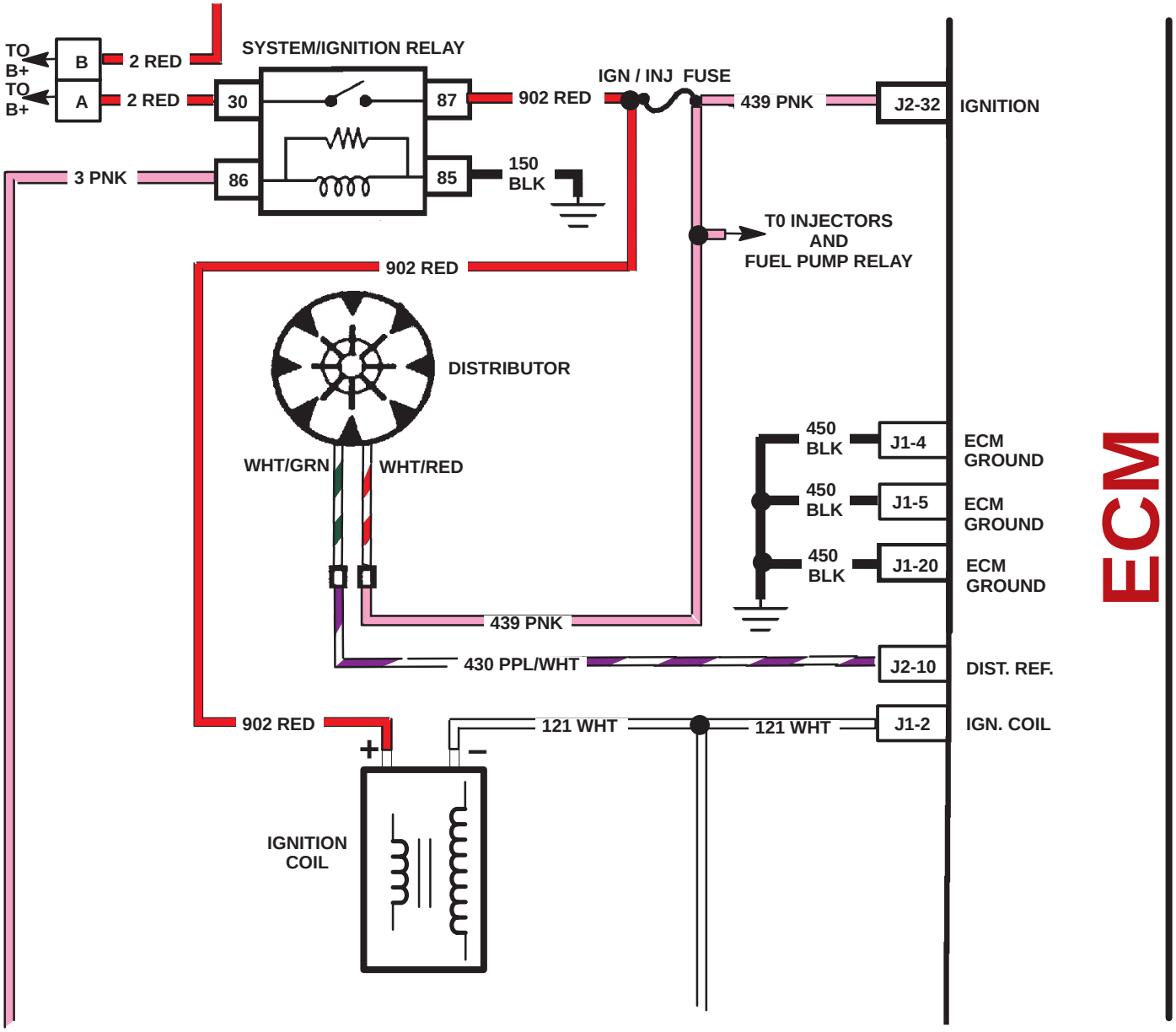
The two other lines between the ECM and distributor which control the Electronic Spark Timing (EST) operation are known as the bypass and IC (Ignition Control) circuits.



EFI Engines with Mercury Marine (Thunderbolt V) Distributor and MEFI-3 ECM - 1999 V-6 and Small Block V-8 Engines

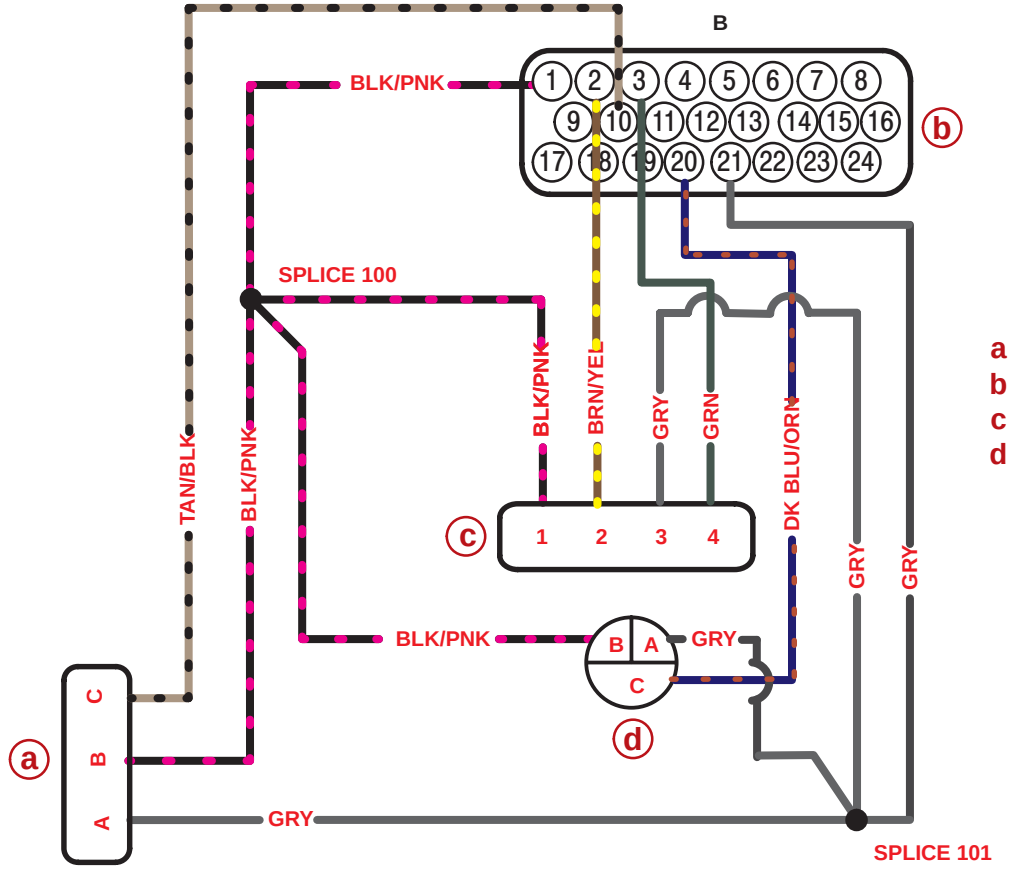
These EFI/MPI engines (V-6, Small Block V-8) originally used an EST type of distributor. They now use (1999 and later) a Mercury Marine, Thunderbolt V style distributor. This unit only has an ignition sensor. It does not have an ignition module like the EST system.

The sensor provides a square wave (digital) signal to the ECM, which is used as an engine speed reference (rpm) and as a timing reference. The ECM completely controls ignition timing at all engine speeds. This is similar to an EST ignition running in the “ECM Control Mode.” The ignition coil driver (transistor), which was built into the EST ignition module, is now inside the MEFI-3 ECM.



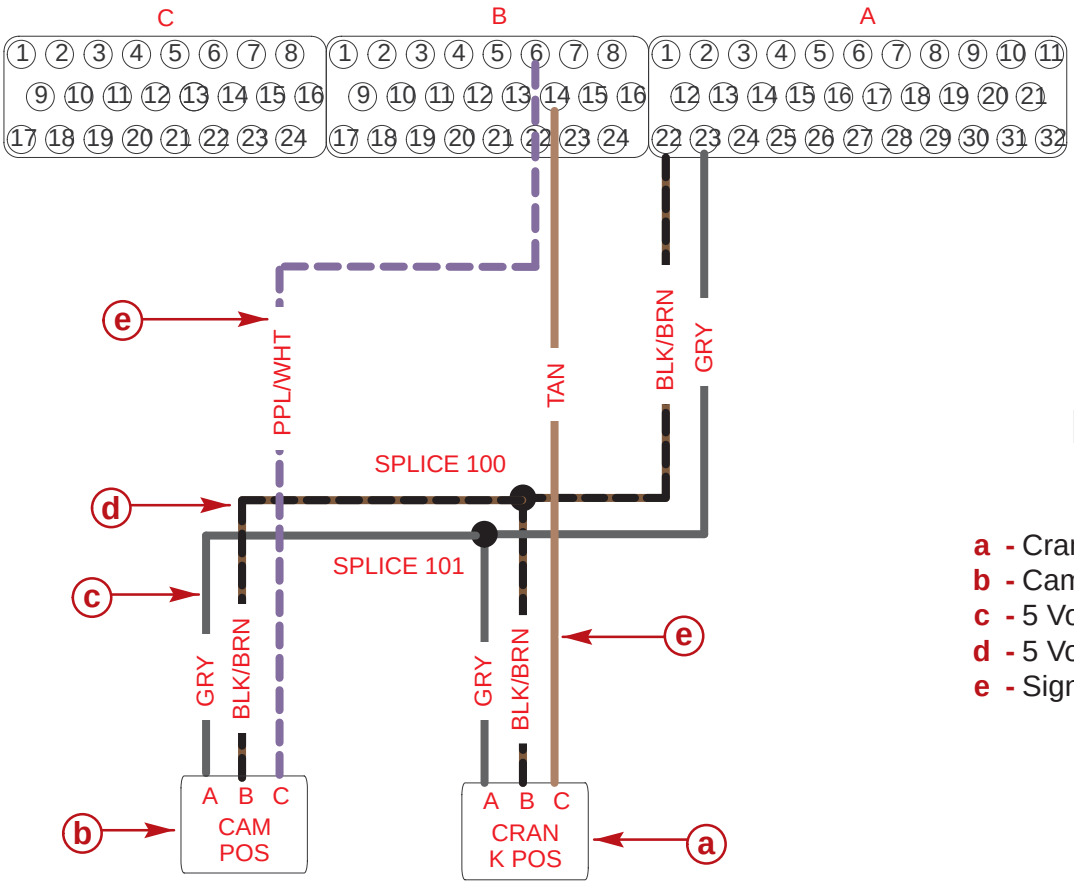
ECM/PCM 555 RPM Input

The crank position sensor sends the RPM signal to the ECM 555 through the tan/black wire and to the PCM 555 through a tan wire.



ECM 555

a - CPS
b - ECM 555
c - MAP/MAT
d - TPS

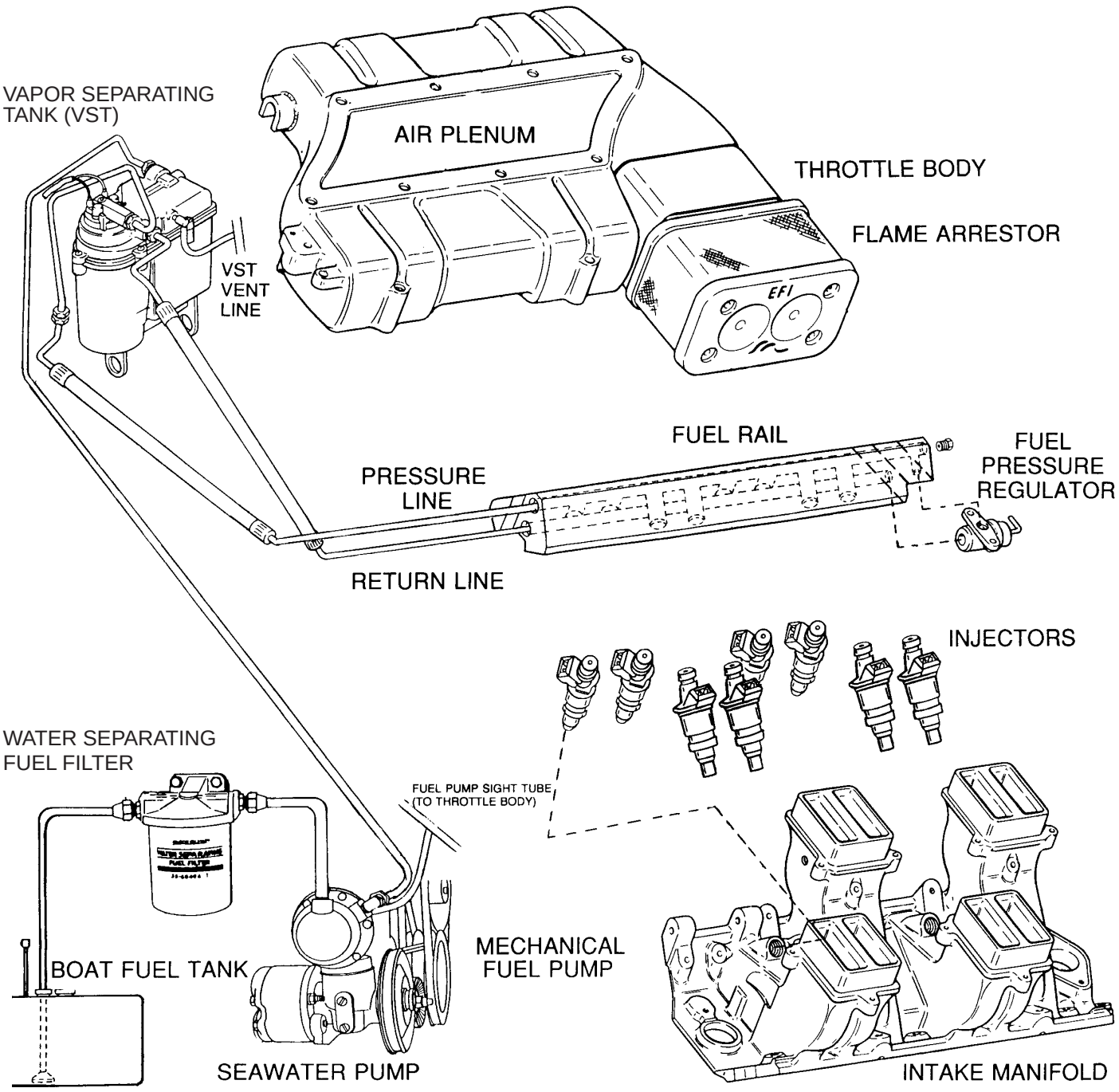


PCM 555

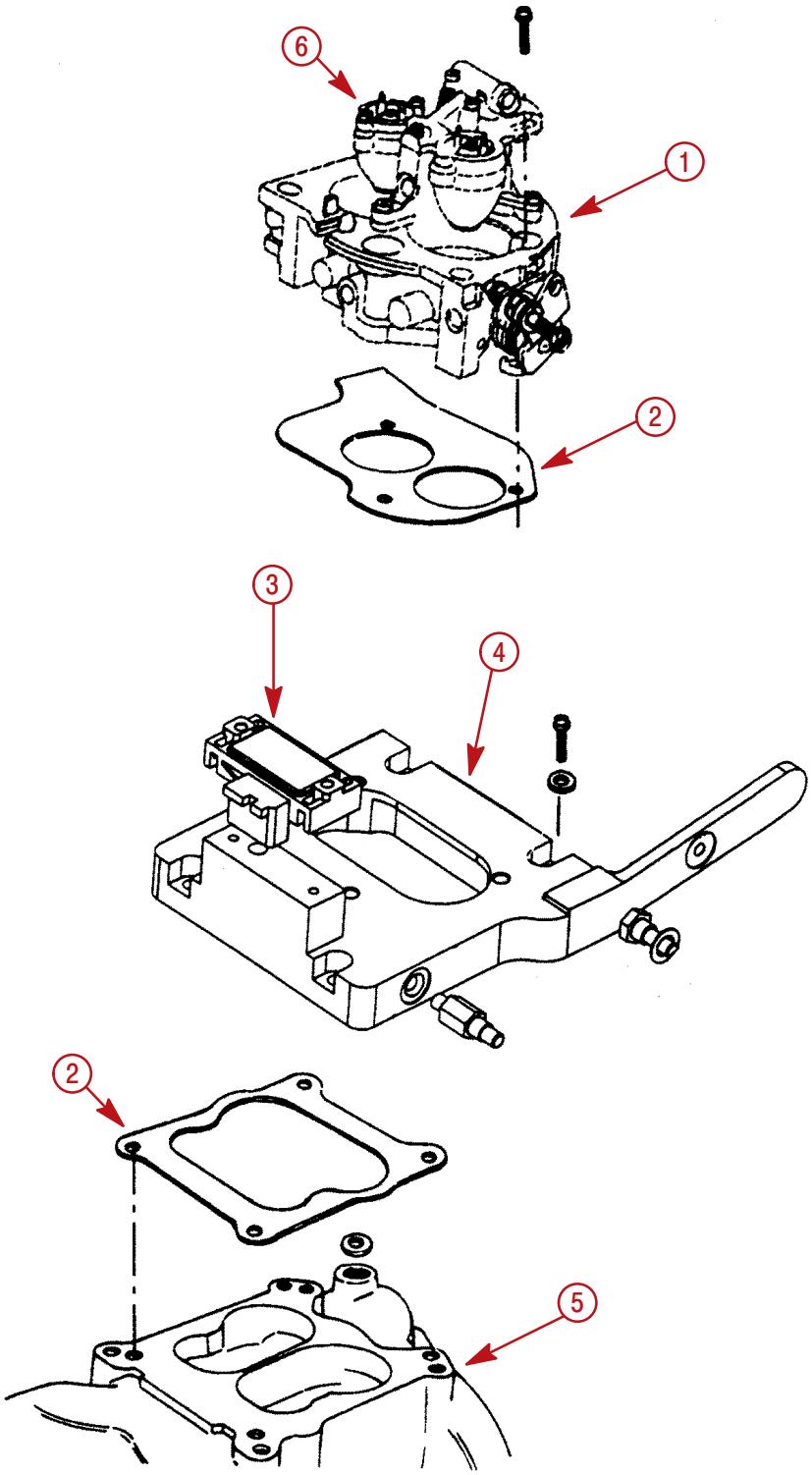
a - Crankshaft Position Sensor
b - Camshaft Position Sensor
c - 5 Volt Power
d - 5 Volt Ground
e - Signal To The PCM

77680

Multi-Port Fuel Injection System – Fuel Flow

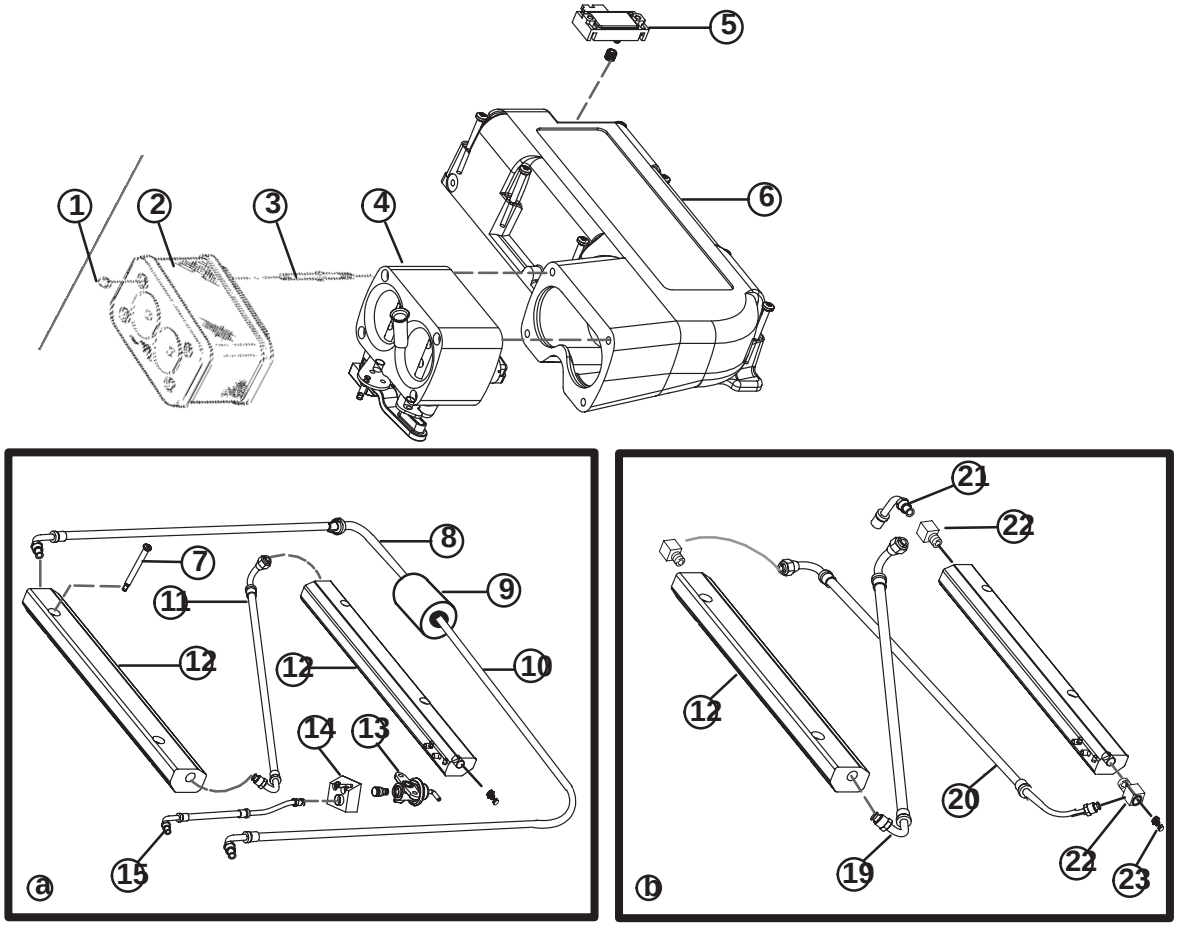


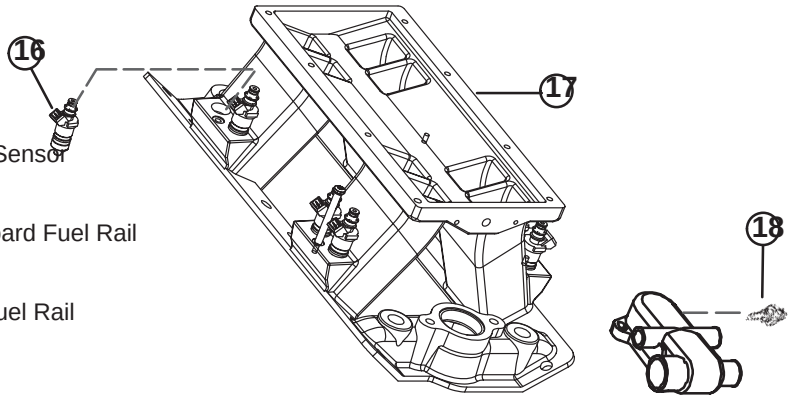
Throttle Body Injection System



1 - Throttle Body
2 - Gasket
3 - MAP
4 - Adapter
5 - Intake Manifold
6 - Injector

Early 350 Mag MPI Induction System





75068

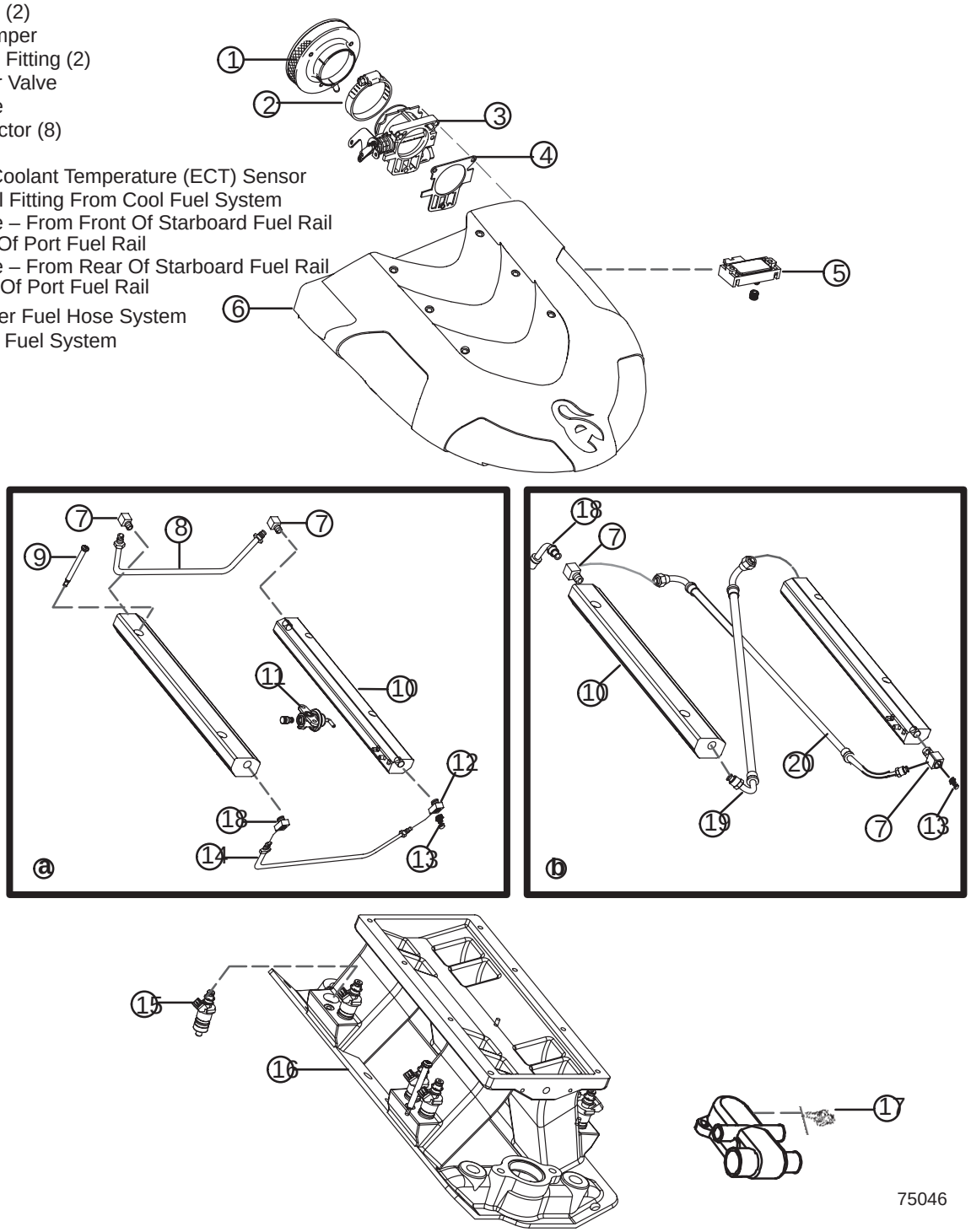
1– Nut (4)
2– Flame Arrestor
3– Stud (4)
4– Throttle Body
5– Manifold Absolute Pressure (MAP) Sensor
6– Plenum
7– Screw (4)
8– Fuel Line From Fuel Filter To Starboard Fuel Rail
9– Fuel Filter
10–Fuel Line From VST To Fuel Filter
11–Fuel Line From Starboard To Port Fuel Rail
12–Fuel Rail (2)
13–Fuel Pressure Regulator
14–Fuel Block
15–Fuel Line From Fuel Block To VST
16–Fuel Injector (8)
17–Intake Manifold
18–Engine Coolant Temperature (ECT) Sensor
19–Fuel Line – From Front Of Starboard Fuel Rail To Rear Of Port Fuel Rail
20–Fuel Line – From Rear Of Starboard Fuel Rail To Front Of Port Fuel Rail
21–Fuel Line From Cool Fuel System
22–Adapter Block
23–Schrader Valve

a – VST Equipped System
b – Cool Fuel System

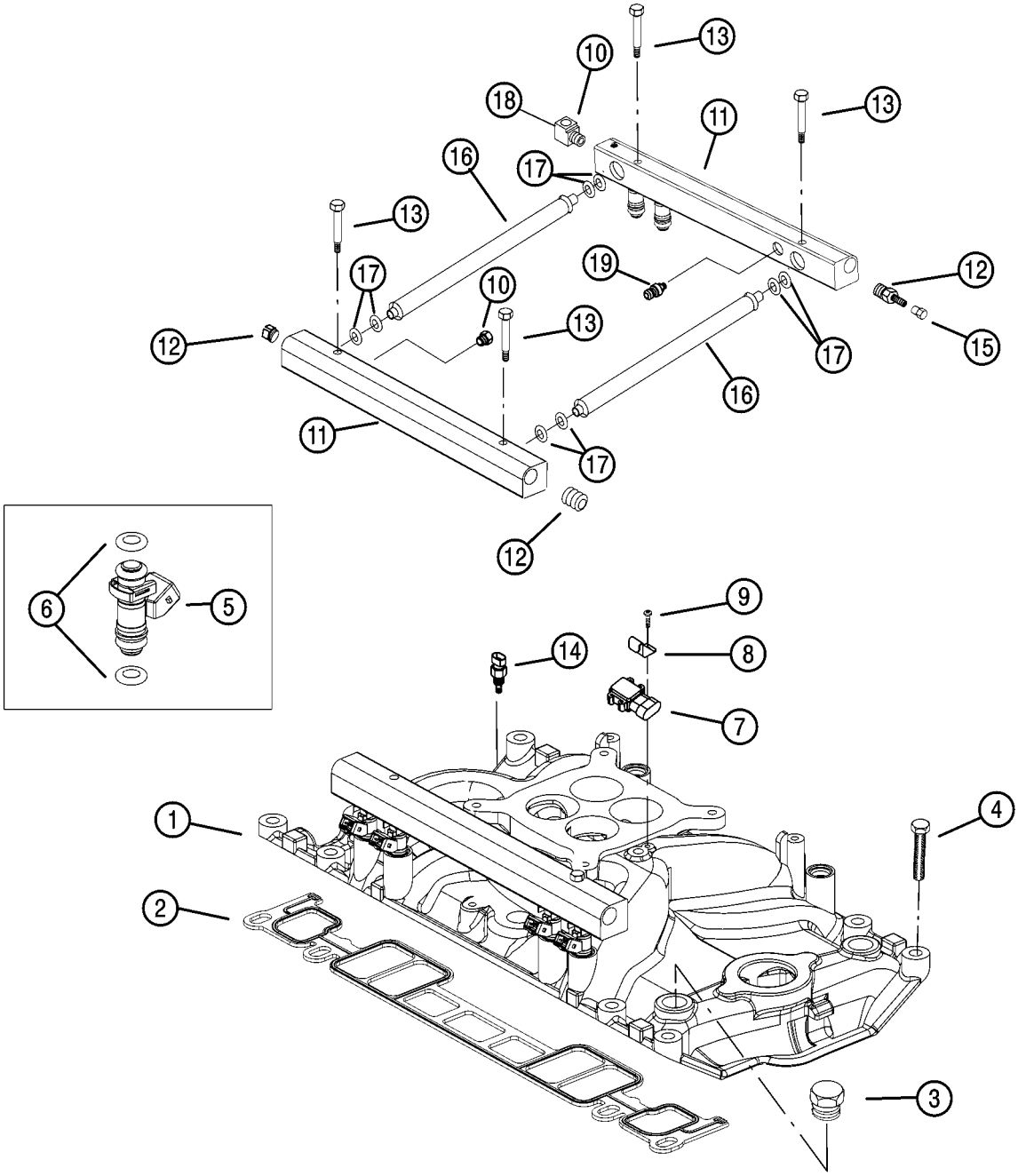
350 MPI Magnum Gen + Tournament Ski (Black Scorpion) Induction System

1– Flame Arrestor
2– Flame Arrestor Clamp
3– Throttle Body
4– Throttle Body Gasket
5– Manifold Absolute Pressure (MAP) Sensor
6– Plenum
7– Fuel Rail Fitting (2)
8– Fuel Line
9– Screw (2)
10– Fuel Rail (2)
11– Fuel Damper
12– Fuel Rail Fitting (2)
13– Schrader Valve
14– Fuel Line
15– Fuel Injector (8)
16– Manifold
17– Engine Coolant Temperature (ECT) Sensor
18– Inlet Fuel Fitting From Cool Fuel System
19– Fuel Line – From Front Of Starboard Fuel Rail To Rear Of Port Fuel Rail
20– Fuel Line – From Rear Of Starboard Fuel Rail To Front Of Port Fuel Rail

a – Earlier Fuel Hose System
b – Cool Fuel System



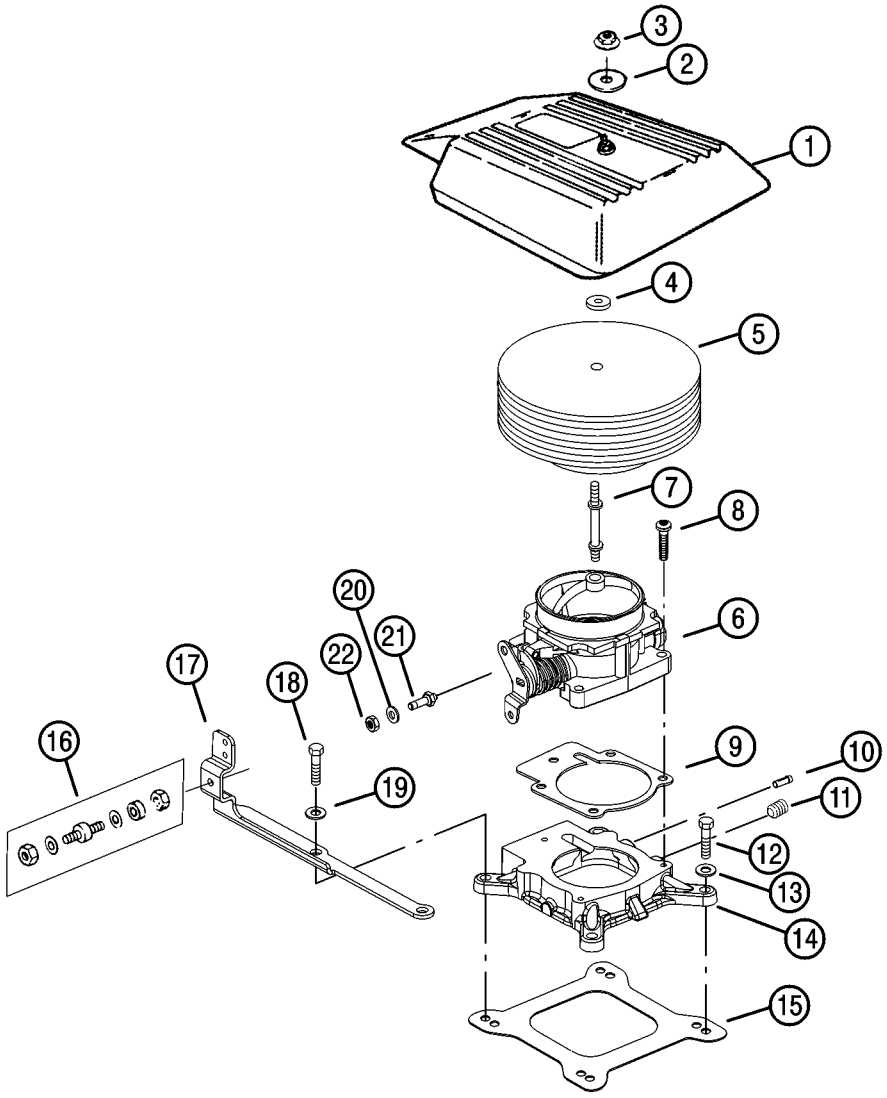
Later Model 350 Mag MPI Induction System – MEFI 3 Model (MEFI 1 & 2 Similiar)



MEFI 3 Models **(MEFI 1 & 2 Similar)**

1 - Intake Manifold
2 - Gasket
3 - Pipe Plug
4 - Screw [5/16-18 x1-3/8 in. (35 mm)]
5 - Fuel Injector
6 - O-Ring
7 - MAP Sensor
8 - Clip
9 - Screw [#8-32 x 1/4 in. (6 mm)]
10 - Pipe Plug (1/8 in. hex head)
11 - Fuel Rail
12 - Schrader Valve
13 - Screws (1/4-20 x 1-1/2 in.)
14 - MAT Sensor
15 - Cap
16 - Fuel Lines
17 - O-Rings
18 - Location of Fuel Line From Fuel Pump
19 - Pressure Sensor

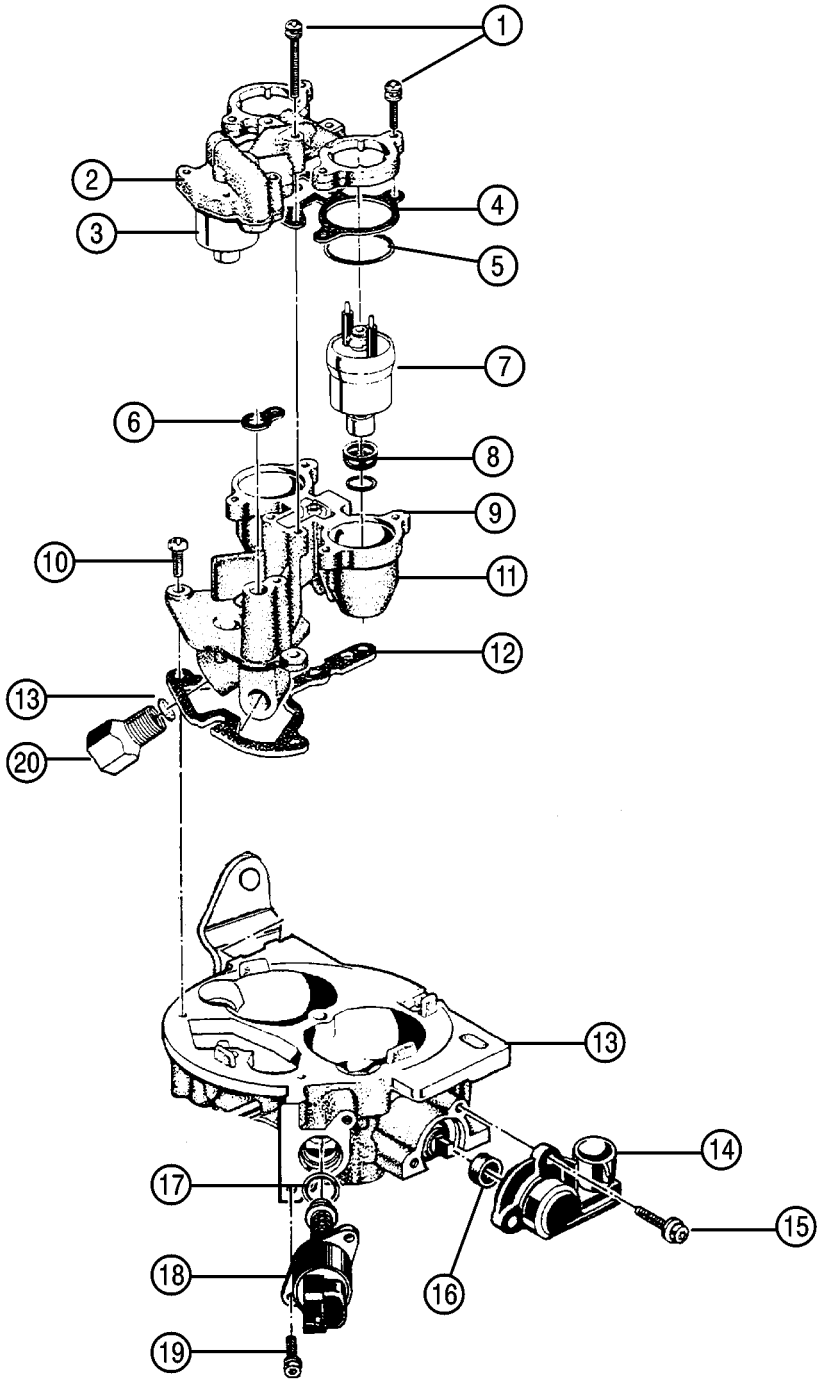
Later Model 350 Mag MPI Throttle Body Assembly – MEFI 3



Later Models

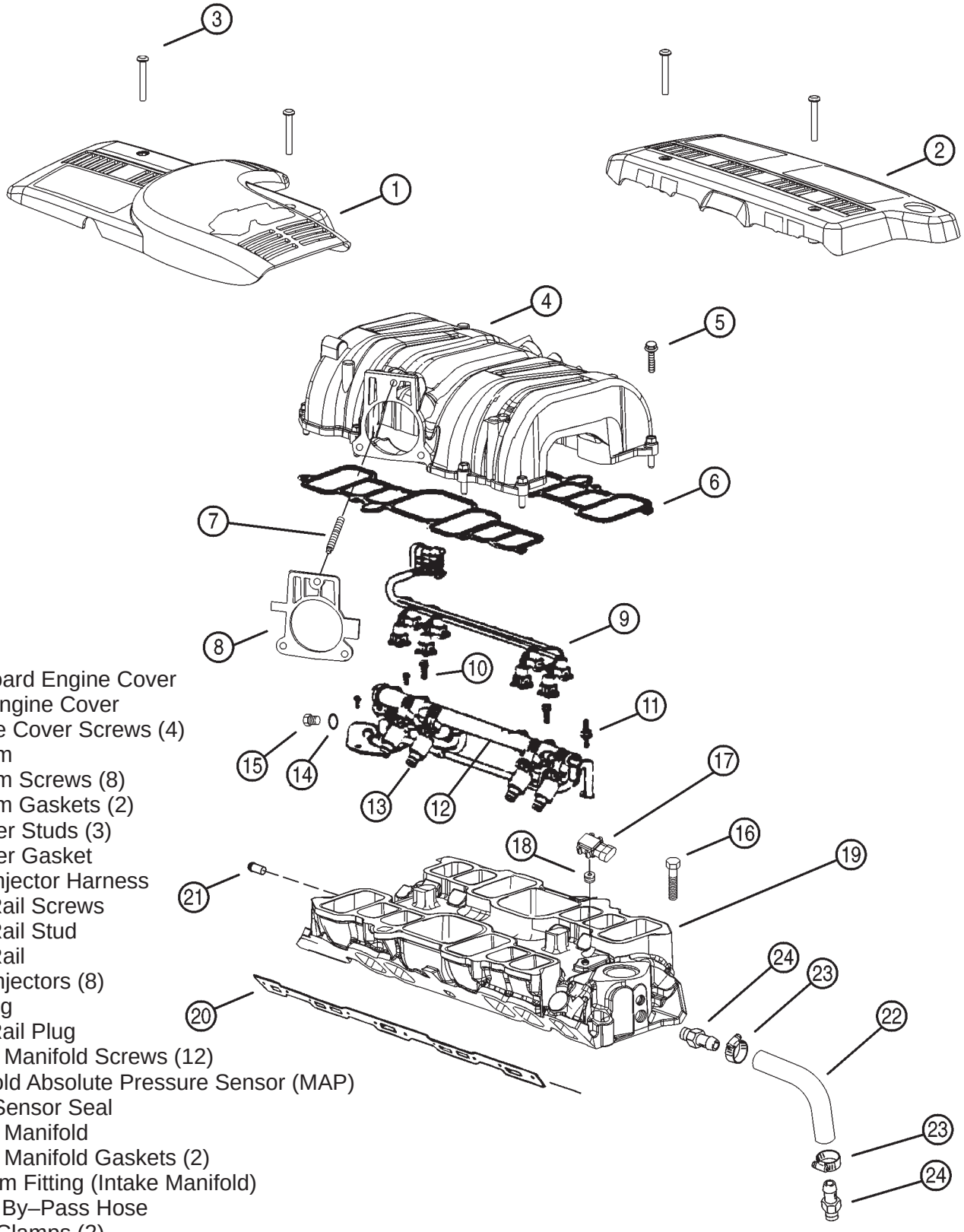
1 - Cover
2 - Washer
3 - Nut (1/4-28)
4 - Washer
5 - Flame Arrestor
6 - Throttle Body Assembly
7 - Stud
8 - Screw (1/4-20)
9 - Gasket
10 - 3/16 in. Barb Fitting (From Fuel Pressure Regulator)
11 - Pipe Plug (1/4-18 Socket Head)
12 - Screw [5/16-18 x 1-1/4 in. (32 mm)]
13 - Washer
14 - Throttle Body Adaptor Plate
15 - Gasket
16 - Stud Kit
17 - Throttle Cable Bracket
18 - Screw (5/16-18 x 1 in.)
19 - Washer
20 - Washer
21 - Stud (1/4 x 1-3/4 in.)
22 - Nut (1/4-28)

Throttle Body Assembly – TBI (EFI) Models



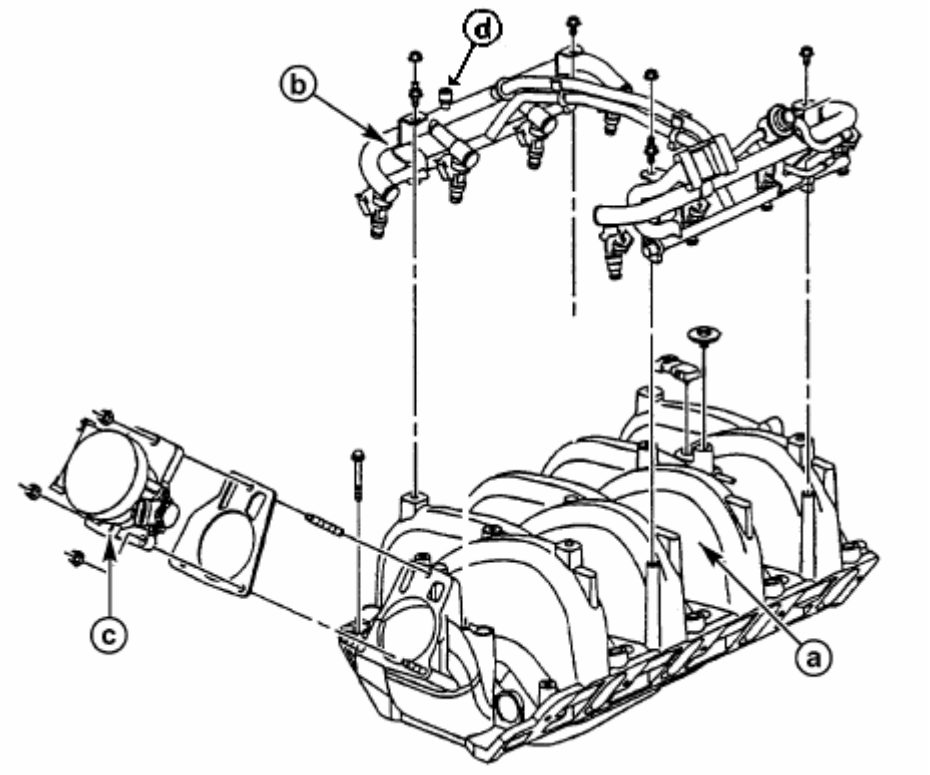
1 - Cap Screw
2 - Cover Assembly
3 - Fuel Pressure Regulator
4 - Cover Assembly Gasket
5 - Upper O-Ring
6 - Fuel Meter Outlet Gasket
7 - Fuel Injector (2)
8 - Fuel Filter (2)
9 - Lower O-Ring
10 - Screw
11 - Body
12 - Throttle Body To Fuel Meter Body Gasket
13 - Throttle Body
14 - Throttle Position (TP) Sensor
15 - Screws (2)
16 - Seal
17 - O-Ring
18 - Idle Air Control (IAC) Valve
19 - Screws (2)
20 - Fuel Inlet

7.4L (L29) MPI Induction System



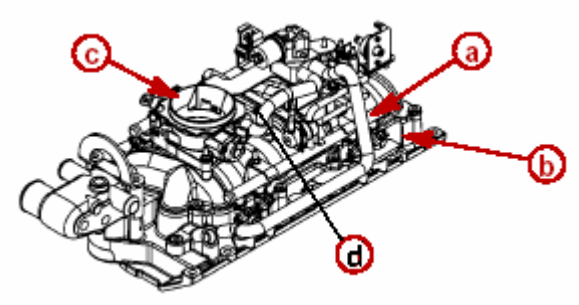
1– Starboard Engine Cover
2– Port Engine Cover
3– Engine Cover Screws (4)
4– Plenum
5– Plenum Screws (8)
6– Plenum Gaskets (2)
7– Adapter Studs (3)
8– Adapter Gasket
9– Fuel Injector Harness
10 –Fuel Rail Screws
11 –Fuel Rail Stud
12 –Fuel Rail
13 –Fuel Injectors (8)
14 –O–Ring
15 –Fuel Rail Plug
16 –Intake Manifold Screws (12)
17 –Manifold Absolute Pressure Sensor (MAP)
18 –MAP Sensor Seal
19 –Intake Manifold
20 –Intake Manifold Gaskets (2)
21 –Vacuum Fitting (Intake Manifold)
22 –Water By–Pass Hose
23 –Hose Clamps (2)
24 –Water By–Pass Fitting (2)

496/8.1L MPI Induction System (Typical)



a - Intake Manifold
b - Fuel Rail
c - Throttle Body
d - Schrader Valve

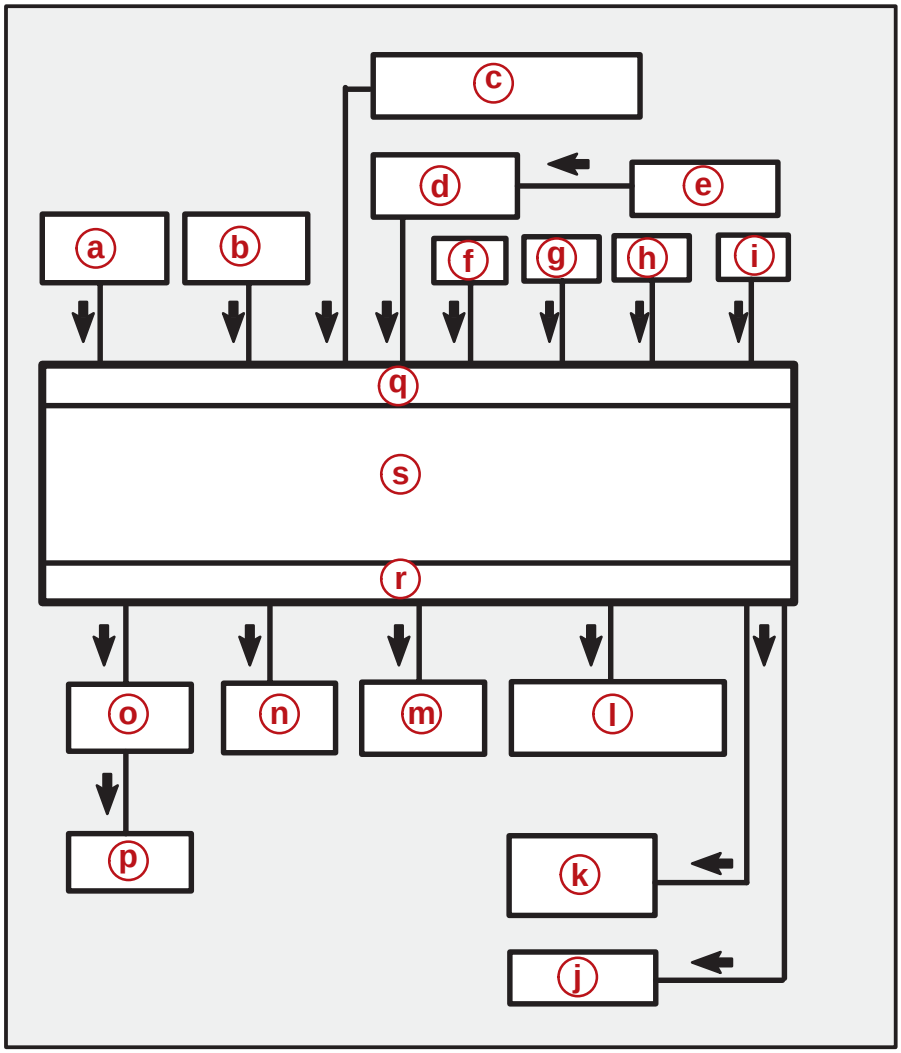
Small Block V-8 Induction System (V-6 Similiar)



a - Fuel Rail Assembly
b - Intake Manifold
c - Throttle Body
d - Schrader Valve

MEFI 1 and 2 ECM Input and Sensor Descriptions (MEFI 3 Similiar)

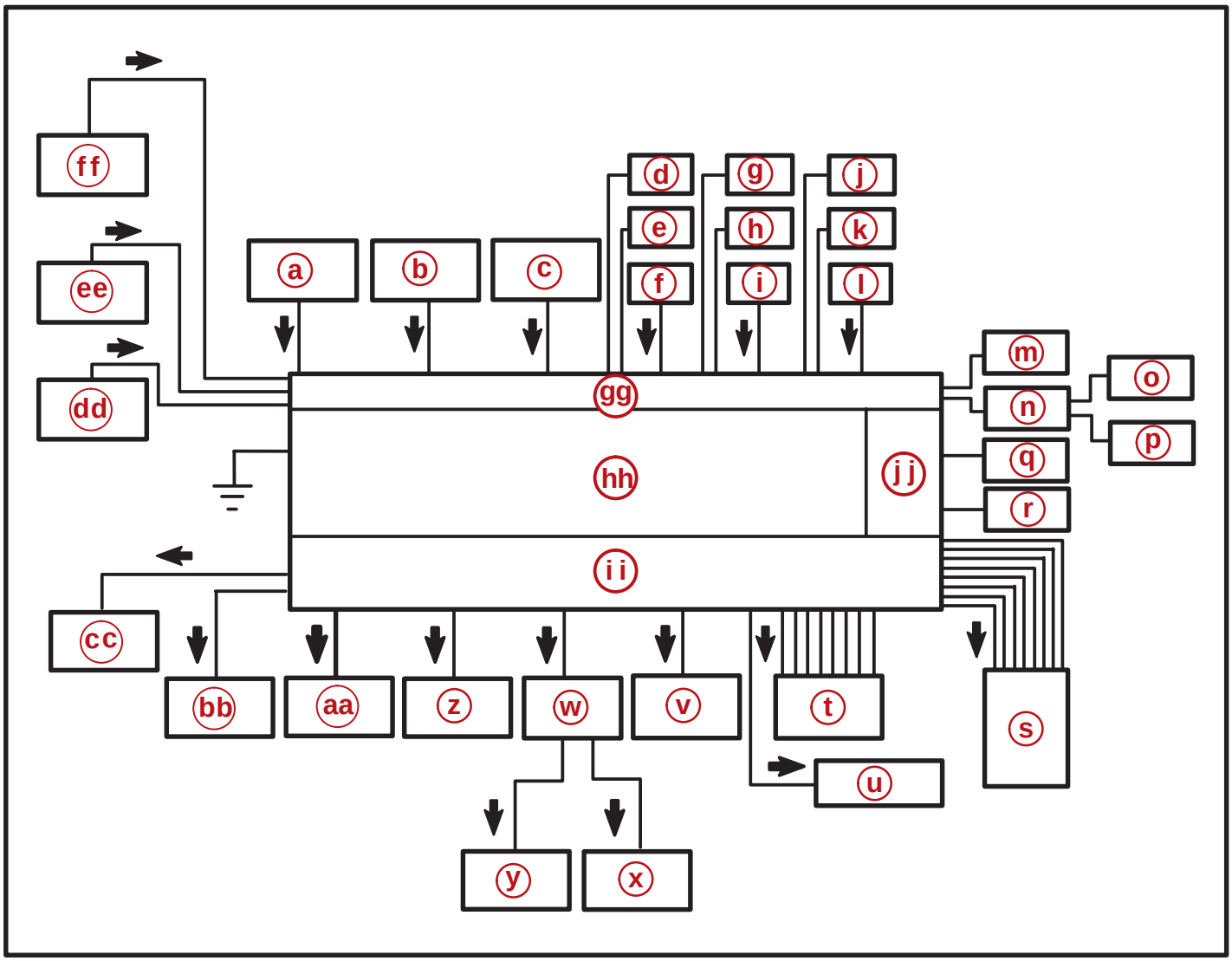
The following lists the sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



a - System Relay
b - Distributor For REF rpm
c - Discrete Switches (Audio Warning)
d - Knock Module
e - Knock Sensor
f - TP
g - MAP
h - ECT
i - IAT
j - Serial Data
k - Audio Warning Buzzer
l - Fuel Injectors
m - IAC Motor
n - Ignition Control Module
o - Fuel Pump Relay
p - Fuel Pump
q - Inputs
r - Outputs
s - ECM

PCM 555 Input and Sensor Descriptions (ECM 555 Similar)

The following lists the sensors, switches, and other inputs used by the PCM 555 to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



a - MAP
b - MAT
c - TP
d - ECT
e - Sea Pump
f - Oil Pressure
g - Port EMCT
h - Starboard EMCT
i - Lube Oil Bottle
j - Knock 1
k - Knock 2
l - Fuel Level
m - Paddle Wheel/Sea Temp
n - Transom Harness
o - Pitot
p - Steering Angle
q - DLC
r - CAN Line
s - Fuel Injectors 1 – 8
t - Ignition Coils 1 – 8
u - Tach Signal
v - IAC
w - Fuel Pump Relay
x - Boost Fuel Pump
y - Cool Fuel Pump
z - Main Power Relay (MPR)
aa - Trim UP Relay
bb - Warning Horn
cc - Tabs
dd - Key B+
ee - Crank Position Sensor (CPS)
ff - Cam Position Sensor (CMP)
gg - Inputs
hh - PCM 555 Controller
ii - Outputs
jj - Input/Output

Abbreviations

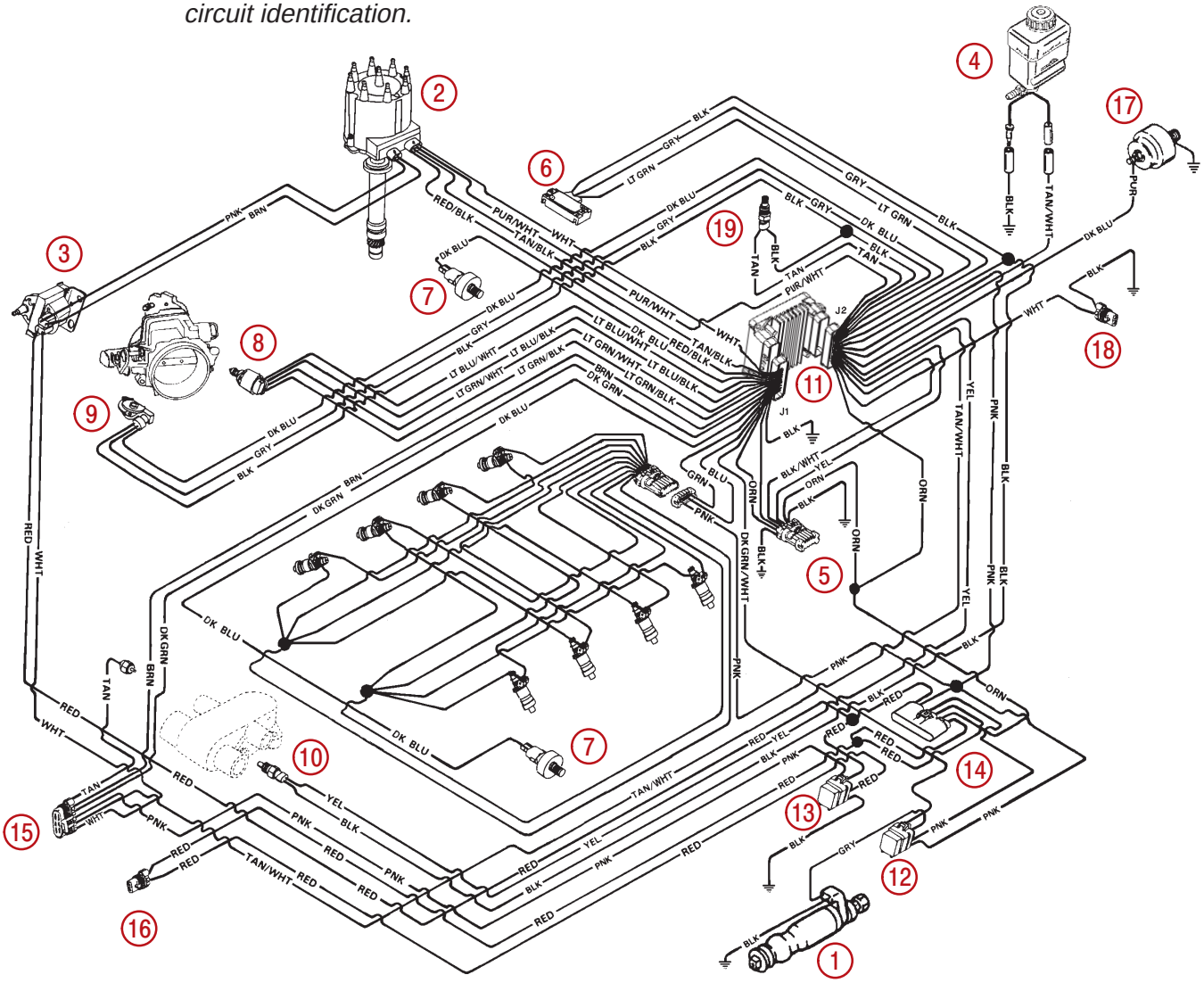
Amp	Amperes	IAC	Idle Air Control
BARO	Barometric Pressure	IAT	Intake Air Temperature
Bat	Battery Positive Terminal, Battery or System Voltage	IC	Ignition Control
B+	Battery Positive	IGN	Ignition
Bps	Beeps	In. hg.	Inches of Mercury
CAM	Camshaft	INJ	Injection
cond	Condition	kPa	Kilopascal
cont	Continuous	KS	Knock Sensor System
Crank	Crankshaft	kV	Kilovolts
CAN	Control Area Network	mA	Milliamperes
CKT	Circuit	MPR	Main Power Relay
CMP	Camshaft Position Sensor	MAP	Manifold Absolute Pressure
Conn	Connector	MAT	Manifold Air Temperature
CPS	Crankshaft Position Sensor	MIL	Malfunction Indicator Lamp
Cyl	Cylinder	mohms	Milliohms
DDT	Digital Diagnostic Tester	mSec	Millisecond
Deg	Degrees	N/C	Normally Closed
Diag	Diagnostic	N/O	Normally Open
DIS	Distributorless Ignition System	PCM	Propulsion Control Module
Dist	Distributor	PROM	Programmable Read Only Memory
DLC	Data Link Connector	RAM	Random Access Memory
DTC	Diagnostic Trouble Code	REF HI	Reference High
DVOM	Digital Volt Ohm Meter	REF LO	Reference Low
DMM	Digital Multimeter	ROM	Read Only Memory
DMT	Digital Multimeter & Tachometer	SLV	Slave
ECM	Engine Control Module	SW	Switch
ECT	Engine Coolant Temperature	TACH	Tachometer
EEPROM	Electronically Erasable Programmable Read Only Memory	Term	Terminal
EFI	Electronic Fuel Injection	TPS	Throttle Position Sensor
EMCT	Exhaust Manifold Coolant Temperature	V	Volts
EMI	Electromagnetic Interference	Vac	Vacuum
ERC	Electronic Remote Control	WOT	Wide Open Throttle
ESC	Electronic Shift Control		
ETC	Electronic Throttle Control		
GND	Ground		
HEI	High Energy Ignition		
HVS	High Voltage Switch		

MerCruiser EFI System - Electronic Components

MEFI 3 MCM (Sterndrive) 7.4L MPI Bravo and MIE (Inboard) 7.4L Inboard

NOTE: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

NOTE: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*



1 - Fuel Pump	**13 -** Ignition/System Relay
2 - Distributor	**14 -** Fuse (15 Amp) Fuel Pump Fuse (15 Amp) ECM / DLC / Battery Fuse (10 Amp) ECM / Injector / Ignition / Knock Module
3 - Coil	**15 -** Harness Connector To Starting/Charging Harness
4 - Gear Lube Monitor Bottle (Not Used On MIE)	**16 -** Positive (+) Power Wire To Engine Circuit Breaker
5 - Data Link Connector (DLC)	**17 -** Oil Pressure - Audio Warning Switch
6 - Manifold Absolute Pressure (MAP) Sensor	**18 -** Load Anticipation Circuit (Not Used On MCM)
7 - Knock Sensor	**19 -** Intake Air Temperature (IAT) Sensor
8 - Idle Air Control (IAC)	
9 - Throttle Position (TP) Sensor	
10 - Engine Coolant Temperature (ECT) Sensor	
11 - Electronic Control Module (ECM)	
12 - Fuel Pump Relay	

MerCruiser EFI System - Electronic Components
(see previous page for component location – see part numbers)

ENGINE CONTROL MODULE (ECM) (#11)

The ECM is the control center for the fuel injection system. It constantly monitors information from various sensors (engine temperature, throttle opening, engine speed, air temperature and pressure) and controls the systems that affect engine performance (engine timing and injector pulse width).

The ECM supplies 5 or 12 volts to power various sensors or switches. The ECM can also perform a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.

The following sensors interact with the ECM

MANIFOLD ABSOLUTE PRESSURE SENSOR (MAP) (#6)

The Manifold Absolute Pressure Sensor (MAP) is a three wire sensor and is mounted at the rear of the intake plenum. It is a pressure transducer that measures the changes in intake manifold pressure caused by engine load and speed. The MAP sensor also is used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

DISTRIBUTOR REFERENCE SIGNAL (DIST. REF) (#2)

A Distributor Reference Signal (Dist. Ref) is sent to the ECM from the Ignition Module in the distributor housing. This reference signal is the timing signal for ignition timing and pulsing the fuel injectors as well as the RPM counter for the ECM.

ENGINE COOLANT TEMPERATURE SENSOR (ECT) (#10)

The Engine Coolant Temperature Sensor (ECT) is located on the port side of the thermostat housing. It sends a signal to the ECM letting it know if the engine is warm or cold.

THROTTLE POSITION SENSOR (TP) (#9)

The Throttle Position Sensor (TP) is mounted on the underside of the throttle body assembly. As the throttle is opened the TP sends out a changing voltage signal to the ECM so that it can adjust the fuel delivery. The TP also signals the ECM when the throttle is opened rapidly so it can add extra fuel for acceleration.

MANIFOLD / INTAKE AIR TEMPERATURE SENSOR (MAT or IAT) (#19)

The Intake Air Temperature Sensor (IAT) is a two wire sensor mounted on the under side of the intake air plenum. It measures the temperature of the incoming air.

IDLE AIR CONTROL VALVE (IAC) (#8)

The Idle Air Control Valve (IAC) is mounted into the side of the throttle body assembly and controlled by the ECM. This valve controls engine idle speed by controlling the amount of air that bypasses the throttle valves through the idle air passage in the throttle body. It also prevents stalls due to a change in engine RPM. The valve moves in and out of the idle air passage to decrease or increase air flow as required.

KNOCK SENSOR (#7)

The Knock Sensor is mounted in the lower side of the engine block. When abnormal engine vibrations occur because of spark knock, the sensor produces a signal that is sent to the ECM.

DISCRETE SWITCH INPUTS (#4, #17)

Two discrete switch inputs are used to identify abnormal conditions that may effect engine operation, a low oil pressure switch and low drive unit fluid level switch are wired to the ECM. They signal the module of low oil pressure or low drive unit fluid. Both discrete switches are in a normal open mode when the engine is running. The warning horn will sound if there is a problem.

Inboard models use a transmission temperature switch instead of the low drive unit fluid level switch. If the transmission temperature gets too high, the switch will signal the ECM of this condition.

The following are additional sensors used on the PCM 555 EFI System:

EXHAUST MANIFOLD COOLANT TEMPERATURE SENSORS (EMCT)

There are two Exhaust Manifold Coolant Temperature Sensors (EMCT), one in each exhaust manifold (port and starboard). They are located at the mounting flange between each manifold and its elbow. Both EMCT sensors are two-wire sensors and their primary purpose is to tell the Guardian program the temperature of the coolant in each exhaust manifold. Both EMCT sensors are thermistors and operate in the same manner as the ECT sensor. A failure in either EMCT will set a specific fault for that sensor.

CRANKSHAFT POSITION SENSOR (CPS)

The Crankshaft Position Sensor is a 3-wire Hall-Effect sensor and is mounted on the rear of the engine on the port side. The sensor extends all of the way down to a timing wheel, permanently attached to the crankshaft. Windows and vanes of the timing wheel pass near the sensor, causing it to turn on and off. The result is a square-wave 5 Vdc signal sent back to the PCM. This signal informs the PCM of crankshaft position and engine RPM. The sensor’s position is fixed and cannot be adjusted. There is also no air gap adjustment on this sensor. A failure of the Crankshaft Position Sensor (or its circuit) will not set a fault.

CAMSHAFT POSITION SENSOR (CMP)

The Camshaft Position Sensor is another 3-wire Hall-Effect sensor and is mounted on the timing cover at the front of the engine. The sensor extends close to the camshaft gear, which is specially machined to provide a single window and single vane that passes near the sensor, causing it to turn on and off. The result is a square-wave 5 Vdc signal sent back to the PCM. This signal informs the PCM of camshaft position. The camshaft position signal lets the PCM know whether a cylinder is on compression stroke or on exhaust stroke, so the PCM can inject fuel and fire the ignition coil on the appropriate stroke. A failure of the Camshaft Position Sensor (or its circuit) will set a fault and will result in the PCM firing the ignition coils each revolution (often called “waste-spark”), instead of every other revolution. The fuel injectors will also operate in “sequential” mode, where they all fire individually.

OIL PRESSURE SENSOR

The Oil Pressure Sensor is a three-wire sensor and is mounted just above the remote oil filter adapter on the port side of the crankcase. It is a pressure transducer and its primary purpose is to supply oil pressure information to the Guardian program. A failure in the Oil Pressure sensor (or its circuit) will set a fault.

SEA PUMP PRESSURE SENSOR

The Sea Pump Pressure Sensor is also a three-wire sensor and it is mounted in the sea pump body (on the front, starboard, lower corner of the engine). It is a pressure transducer and its primary purpose is to supply sea pump pressure information to the Guardian program. A failure in the Sea Pump Pressure sensor (or its circuit) will set a fault.

OTHER COMPONENTS ASSOCIATED WITH THE ECM

The provision for communicating with the ECM is the **Data Link Connector (DLC) (#5) Connector.** It is part of the EFI engine wiring harness and is electrically connected to the ECM. The codes stored in the ECM can be read through the DLC connector.

There are three **fuses (#14)** located in a holder near the ECM. One 15 amp fuse is for the fuel pump and relay. A 10 amp fuse for the ECM/Injectors and a 15 amp fuse for the ECM/Battery.

There are different modes of engine operation.

STARTING MODE

With the ignition switch in the start position the ECM will turn on the fuel pump relay. The electric fuel pump runs and pressurizes the fuel in the fuel rail. The ECM then checks the Engine Coolant Temperature Sensor (ECT) and Throttle Position Sensor (TP) to determine the proper air/fuel ratio for starting. The ECM controls the fuel delivered to the engine by changing the pulse width of the injectors.

RUNNING MODE

When the engine is running the ECM checks the inputs from the following sensors to calculate the required air/fuel ratio:

1. Distributor Reference Signal for engine RPM
2. Manifold Absolute Pressure Sensor (MAP)
3. Intake Air Temperature Sensor (IAT)
4. Engine Coolant Temperature Sensor (ECT)

Higher RPM or higher Manifold Absolute Pressure (equals lower vacuum in the manifold), or Lower Intake Air Temperature, or Lower Engine Coolant Temperature signals the ECM to provide a richer fuel/air ratio for the engine.

Lower RPM or lower Manifold Absolute Pressure (equals higher vacuum in the manifold), or higher Intake Air Temperature, or higher Engine Coolant Temperature signals from these sensors would cause the ECM to provide a leaner fuel/air ratio to the engine.

ACCELERATION MODE

Rapid changes in Throttle Position Sensor (TP) and Manifold Absolute Pressure Sensor (MAP) signals to the ECM will cause the ECM to provide extra fuel to the engine. The ECM achieves this by holding the fuel injectors OPEN for a longer period of time.

CLEAR FLOOD MODE

If an EFI engine floods, it can be cleared by positioning the throttle one-half to three-quarters open. When the TP sensor reads between 50 and 75% at cranking rpm, the ECM will not fire the fuel injectors at all. This will allow air to be drawn into the engine, but no fuel injected. As soon as the engine starts and exceeds 300 rpm, the ECM cancels the clear flood mode and enters “running mode”. Not active on ECM/PCM 555 equipped engines.

FUEL CUTOFF MODE

The ECM cuts off fuel delivery to the engine; when the key is off (to prevent dieseling), when no distributor reference pulses are sent (means the engine is not running) and at high engine RPM (overspeed protection).

DECELERATION MODE

The Idle Air Control Valve (IAC) is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from stalling.

POWER REDUCTION MODE (1995 AND EARLIER EFI ENGINES [EARLY MEFI 1])

The two discrete switch inputs and the ECT (engine coolant temperature) sensor are used by the EFI system to identify abnormal conditions that affect engine operations. If engine oil pressure drops too low, or if drive unit fluid level (in the reservoir bottle) becomes too low, or if the engine coolant temperature becomes too high, the ECM will engage the “power reduction mode”. The “power reduction mode” allows normal fuel injection and full power up to 2,800 rpm. Above 2800 rpm, fuel delivery is limited to 1 injector (TBI models) or 4 injectors (MPI models) until rpm falls below 1200. The engine will then resume normal operation with all injectors firing. If the problem goes away (while power reduction mode is engaged), the engine immediately resumes normal operation.

EFI System Air Delivery Components

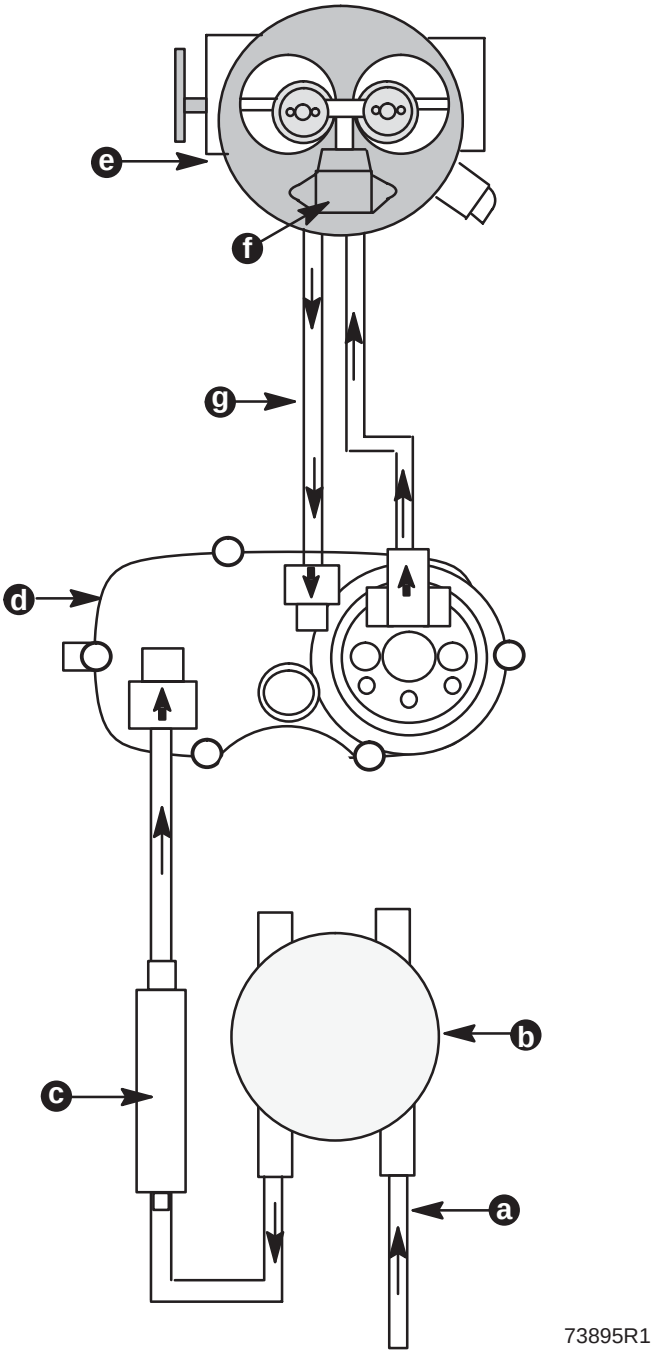
THROTTLE BODY

The throttle body assembly is attached to the plenum and is used to control air flow into the engine. The Throttle Position (TP) Sensor is mounted on the throttle body and is used for sensing throttle valve position. The Idle Air Control (IAC) valve is also mounted on the throttle body and is used to control idle speed and to prevent engine stalls due to changes in engine load.

NOTE: *Later EFI systems have additional sensors which are covered in the service manuals.*

Fuel Systems - Electronic Fuel Injection

Throttle Body Injection With Vapor Separator Tank (VST)



a - Fuel Line from boat's fuel tank
b - Water Separating Fuel Filter
c - Supply pump (mechanical or electric)
d - Vapor separator tank
e - Throttle body with 2 fuel injectors
f - Fuel pressure regulator
g - Return line to vapor separator tank

EFI System Vapor Separator Tank (VST) Description

The MerCruiser EFI Fuel System consists of a fuel supply, water separating fuel filter, mechanical fuel pump, vapor separator tank (VST), electric fuel pump, injector fuel filter, fuel rail, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.

Fuel is drawn from the boat's fuel supply (tank), through a water separating fuel filter, by a mechanical fuel pump mounted on and driven by a seawater pump, and is delivered to the vapor separator tank (VST).

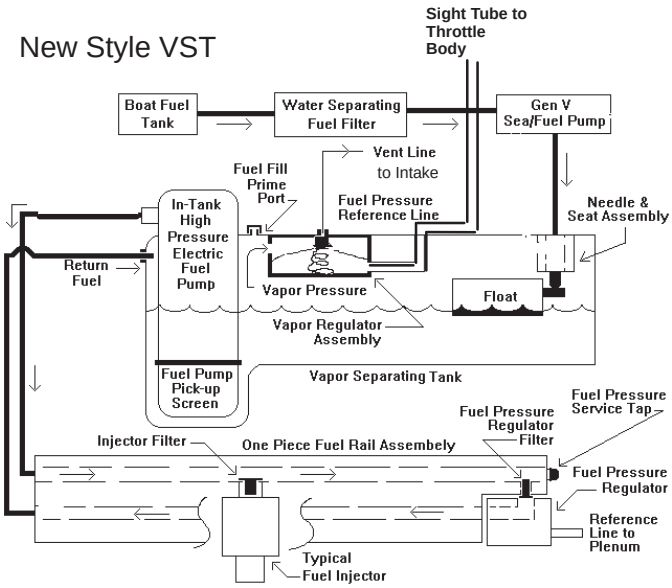
The VST consists of a reservoir, float, needle and seat assembly, fuel pump pickup screen, electric fuel pump. The electric fuel pump located in the VST, pumps the fuel rail supplying pressurized fuel to the fuel injectors.

A pressure regulator located on the fuel rail maintains a constant fuel pressure in the fuel rail. The fuel bled off from the pressure regulator is delivered back to the VST.

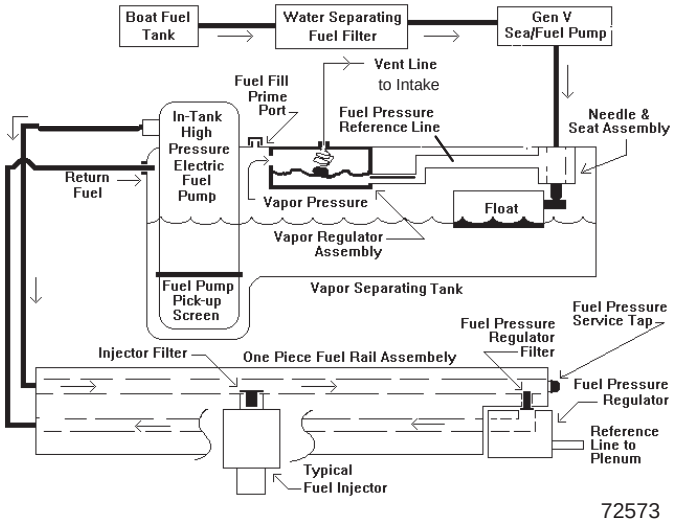
The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Tech Tip: See MC Parts Bulletin 98-6 for VST O-Ring part number.

New Style VST



OLD Style VST



Typical EFI-MPI System with “Cool Fuel” - Fuel Delivery Components **(see diagram on next page)**

FUEL PUMP ELECTRICAL CIRCUIT

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two (2) seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts OFF the fuel pump relay, causing the fuel pump to stop.

When the pump operates, fuel is drawn from the boat’s fuel tank **(a)** and through the water separating fuel filter **(b)**.

WATER-SEPARATING FUEL FILTER (B)

This is a spin-on cartridge (similar to an oil filter) that traps most fuel contaminants. It is easily serviced by replacing the spin-on cartridge. The fuel then passes to the electric fuel pump **(c)**, through a fuel line from the filter.

ELECTRIC FUEL PUMP (C)

The electric fuel pump is mounted parallel to and beneath the fuel cooler **(d)**. This is the only fuel pump used in the “Cool Fuel” fuel delivery system. It is used to draw fuel out of the fuel tank and also to pressurize the fuel delivered to the engine. Fuel is then sent to the fuel cooler **(d)** under pressure.

FUEL COOLER (D)

Engine cooling water is passed through the center of the fuel cooler. The fuel flows through a separate passage that surrounds the outside of the water passage (tube). Fuel can exit the cooler at two locations. The first is through a fuel line to the fuel rail **(i)** and the second is through the fuel pressure regulator **(e)**. Fuel that is sent to the engine passes from the fuel cooler to the fuel rail **(i)**, through a fuel line.

FUEL RAIL (I)

The fuel rail assembly is located on top of the intake manifold. Some systems have a single rail and others use two rails. A fuel rail positions the fuel injectors in the intake manifold and supplies fuel evenly to each injector **(j)**.

FUEL INJECTORS (J)

The fuel injectors are eight electric solenoid operated devices that meter pressurized fuel to each engine cylinder. The Fuel Injectors are controlled by the Electronic Control Module (ECM) which grounds the injector coil to open the injector nozzle and allow fuel to spray into the intake manifold, next to the intake valve. Fuel pressure to the injectors is controlled by the Fuel Pressure Regulator.

FUEL PRESSURE REGULATOR (E)

The fuel pressure regulator is mounted to the top of the fuel cooler, and is connected internally with the fuel passage that surrounds the fuel cooler water passage (tube).

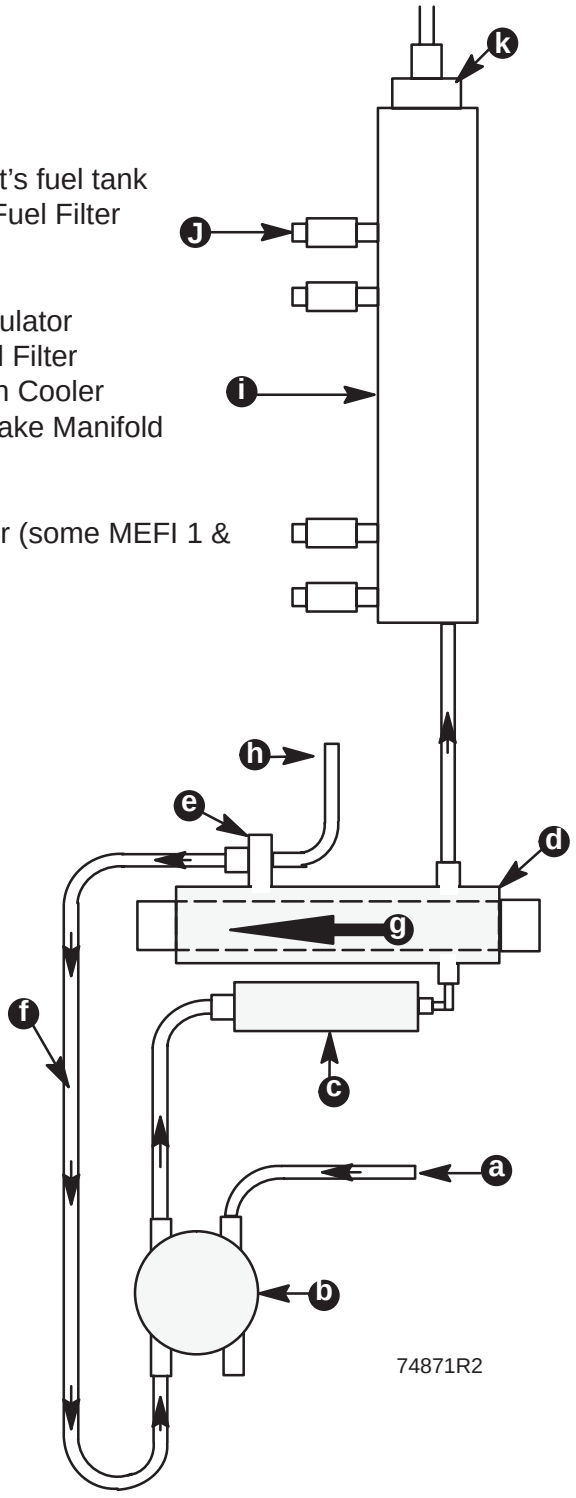
It is a diaphragm-operated relief valve that maintains constant pressure differential across the injectors at all times. An intake manifold vacuum line is attached to the regulator housing and a spring is mounted inside the housing-pushing on the diaphragm. Engine manifold vacuum and the spring counteract each other to apply the correct pressure in the regulator diaphragm under all engine operating conditions. Fuel pressure varies from model to model.

When there is excess fuel in the cooler, that cannot be used by the engine, the fuel pressure regulator is forced open and the extra fuel is bled off and sent through a fuel line **(f)**, back to the water separating fuel filter **(b)**.

WATER-SEPARATING FUEL FILTER (B)

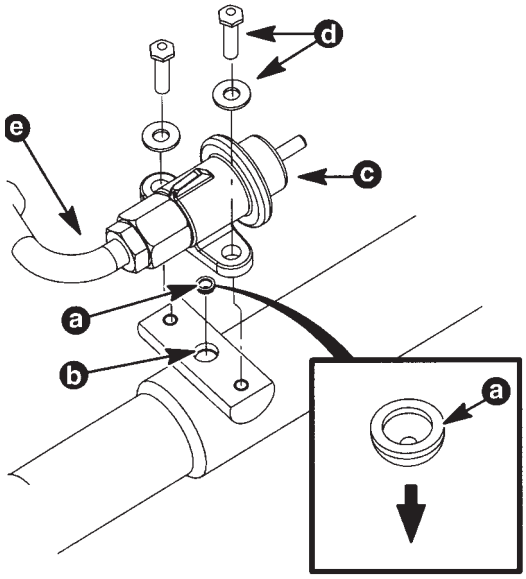
Fuel not used by the engine is returned to the water separating fuel filter where it mixes with fuel coming in from the fuel tank. This fuel is then sent back to the engine. This system does not require a return fuel line to the boat's fuel tank.

a - Fuel Line from boat's fuel tank
b - Water Separating Fuel Filter
c - Electric Fuel Pump
d - Fuel Cooler
e - Fuel Pressure Regulator
f - Return Line to Fuel Filter
g - Water Flow through Cooler
h - Vacuum Line to Intake Manifold
i - Fuel Rail
j - Fuel Injectors (8)
k - "Dummy" Regulator (some MEFI 1 & 2 models)



“Cool Fuel” System Fuel Pressure Regulators

There are 3 different “Cool Fuel”, fuel pressure regulators that are used in production. If the wrong regulator is used on an engine, that engine can have a problem with its fuel supply to the injectors. When checking regulator pressure on MPI engines, always remove the small black hose that goes to the regulator before the test. This hose goes to the intake manifold or plenum and it has vacuum on it, which causes the pressure to read lower at idle RPM. By removing the hose, the regulator’s true pressure will be shown.



75708

a - Filter
b - Fuel Cooler Orifice
c - Pressure Regulator
d - Screw and Washer
e - Fuel Line

There are 2 ways of identifying each regulator by looking at them. By a colored paint mark on its’ mounting flange and by a small ring that is on the regulator’s hose fitting.

ALL TBI ENGINES AND SMALL BLOCK MPI ENGINES:
(Black Scorpion, with Cool Fuel module on starboard side, has a 43 PSI fuel system)

30 psi (207 kPa)

Paint Mark: Pink

Ring on Regulator’s Hose Fitting: None.

ALL 7.4L MPI (L29) ENGINES AND ALL 454/502 MAG EFI/MPI ENGINES WITH MEFI-3 ECM’S AND ECM/PCM 555 ENGINES:

43 psi (296 kPa)

Paint Mark: Blue

Ring on Regulator’s Hose Fitting: Green.

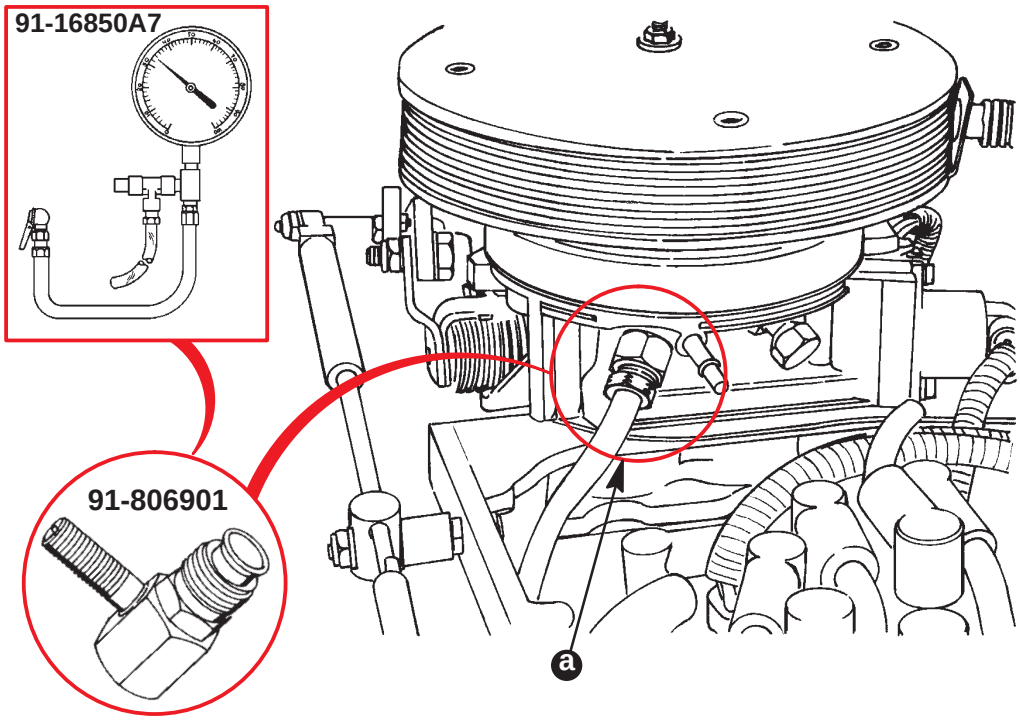
ALL 454/502 MAG MPI ENGINES WITH MEFI-1 ECM’S:

36 psi (248 kPa)

Paint Mark: Yellow and Orange

Ring on Regulator’s Hose Fitting: Black.

Testing Fuel System Pressure on EFI Throttle Body Injection Systems



a - Remove Fuel Line from Throttle Body Unit and Install Fuel Fitting Connector P/N 91-806901. Connect Fuel Pressure Gauge Kit, P/N 91-16850A7, to test system pressure.

Testing Fuel System Pressure on Multi-Port Injection (MPI) Systems

Multi-port (MPI) systems have a permanently installed fuel pressure test port. The location of the test port varies on each model. The fuel system drawings at the beginning of this section show the different port locations.

There are two different size test ports used. One is a Schrader valve and the other one is a G.M. style valve (larger than the Schrader type).

Adaptors are used to attach the fuel pressure test gauge to each size of test port. They are shown on the next page.

Fuel Pressure Test Gauge Adaptor Fittings

The following information is contained in revised Service Bulletin 97-24.

1998-2000 MCM/MIE 7.4L MPI (L29) uses a different size and type of ‘test port’ valve on it for checking the fuel pressure at the fuel rail. The older Fuel Pressure Gauge Kit (P/N 91-16850A 2) will not attach to this valve. A new kit has superseded this kit and it contains 2 fittings so it will fit both types of ‘test ports’ and a TBI pressure valve to allow the gauge to connect to TBI engines.

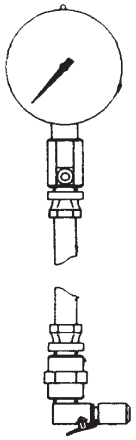
Quicksilver will also sell an Adapter Kit that can be purchased to update the older 91-16850A 2 kit. This kit comes with both size ‘test port’ valve adapters and instructions on how to fit it to the older gauge kit.

91-16850A 7 Fuel Pressure Gauge Kit. Kit contains Adapter Kit and TBI Pressure Valve.

To update older 91-16850A 1, A 2, or A 3 Fuel Pressure Gauge Kits, order the following:

91-806901 TBI Pressure Valve. Allows older Gauge Kits to connect to TBI engines.

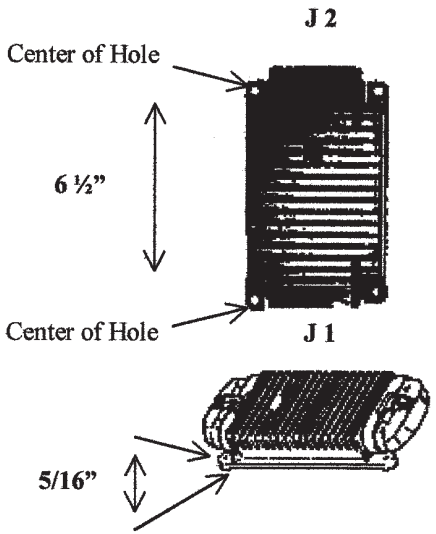
91-803135 Adapter Kit. Allows older Gauge Kits to connect to either type of ‘test port’ valve. (Available after May 1998)



NOTES:

G.M. E. C. M. Identification

MEFI 1/93 Controller

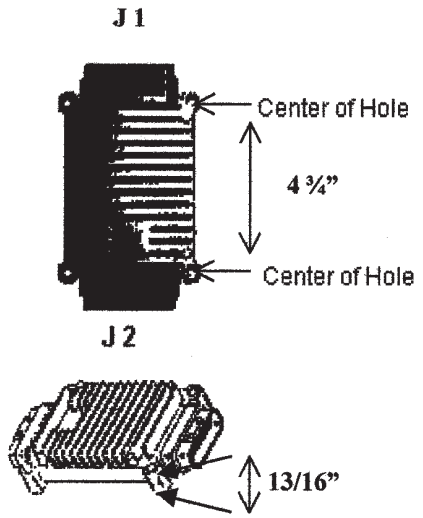


Original GM Marine
E C M Housing

*All ECM's are MEFI 1

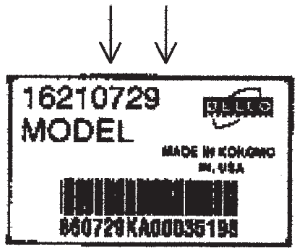
*All ECM's have power reduction

MEFI 1 or 2/96 Controller



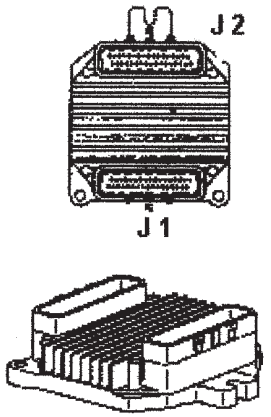
New (Small) GM Marine
E C M Housing

*To Identify between
MEFI 1 & 2, MEFI 2 have
the numbers 729 at the end
of the Model number, shown below



*All other ECM's are MEFI 1

MEFI 3/98 Controller



*All E C M's are MEFI 3

*All current EFI engines use this ECM

*Delphi ECM number 16236999
have floating desired idle speed

(Small block and V-6, not including
Black Scorpion)

*Delphi ECM number 16237009
don't have floating desired idle speed

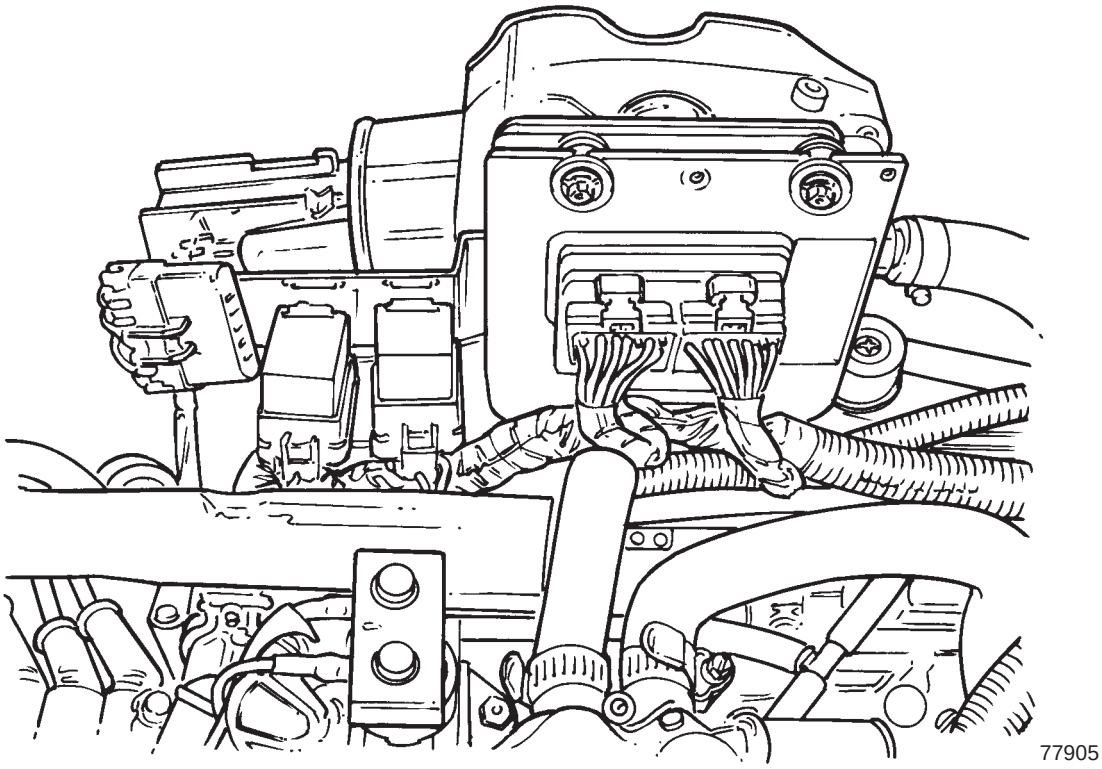
(All current big block and Black Scorpion)

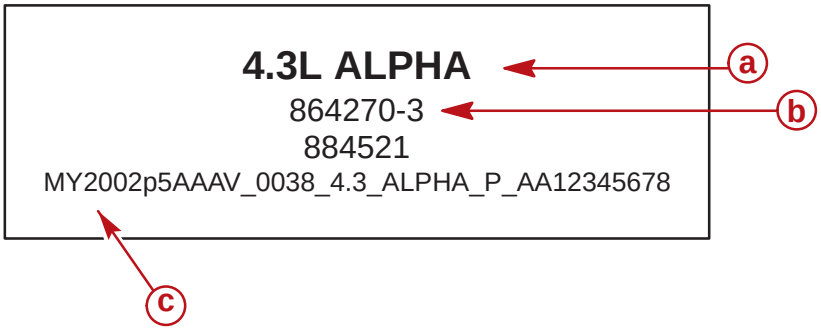
*Note Long term every engine will get the
floating desired idle ECM

ECM 555 Identification

ECM Calibration Label

An ECM can be readily identified by the two wire harness connectors (A-B).





Typical ECM Calibration Label

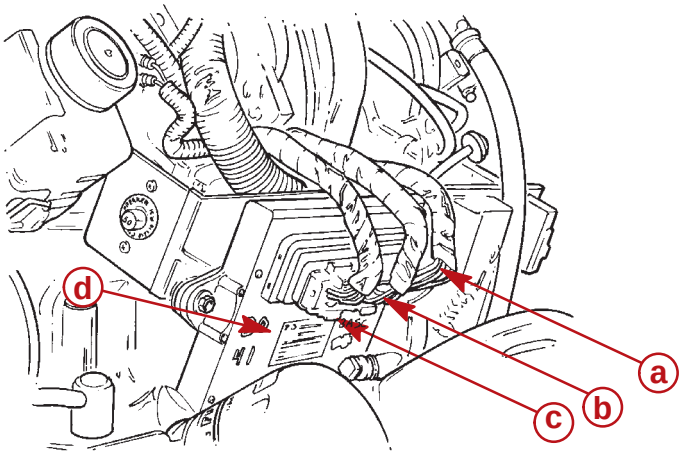
- **a** - Engine Model
- **b** - Calibration Part Number
- **c** - Model Year

The ECM Calibration label includes the information necessary to determine which calibration an engine is equipped with from the factory. The top line is the engine model designation. It is important that Alpha ECM's are only used on Alpha models and Bravo ECM's are only used on Bravo models and Inboard ECM's are used only inboards. The second line specifies the simple calibration number and version. In this case it is calibration 864270, version 3. The bottom line lists the model year of the ECM, in this case 2002, followed by detailed identification numbers of the exact calibration. When calling customer service, make sure you have this information before making the call.

PCM 555 Identification

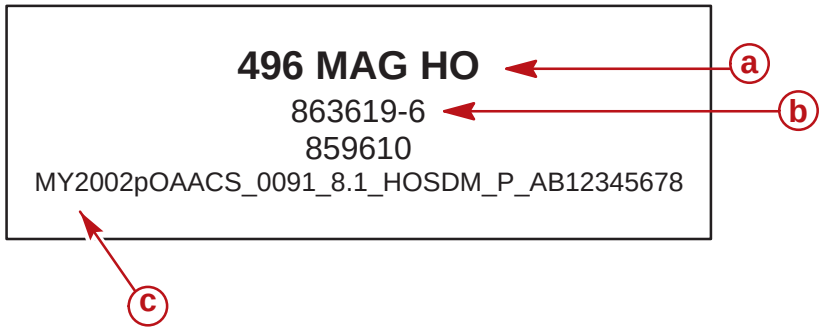
Typical PCM Calibration Label

A PCM can be readily identified by the three wire harness connectors (A-B-C).



77498

a - Connector A
b - Connector B
c - Connector C
d - PCM 555



Typical PCM Calibration Label

a - Engine Model
b - Calibration Part Number
c - Model Year

The PCM Calibration label includes the information necessary to determine which calibration an engine is equipped with from the factory. The top line is the engine model designation. It is important that Bravo ECM's are only used on Bravo models and Inboard ECM's are only used on inboards. Inboard calibrations will contain the acronym "MIE" at the end of the top line. The second line specifies the simple calibration number and version. In this case it is calibration 863619, version 6. The bottom line lists the model year of the ECM, in this case 2002, followed by detailed identification numbers of the exact calibration. When calling customer service, make sure you have this information before making the call.

PCM 555 Engine Guardian Strategy

Engine Guardian is the focal point of the self-diagnostic strategy of PCM 555. It helps protect the engine from possible damage that could result from several faulty conditions. The system monitors the sensors incorporated on the engine and if a malfunction is discovered a fault description is stored in the PCM and available power is normally reduced. By ensuring engine output is at a low enough level, the engine is better protected from thermally induced failures.

For example, if an open or short is found in an exhaust manifold sensor, available power will be reduced to 90% of total, the warning horn will sound 2 beeps per minute and the MercMonitor gauge (SC1000) will display a warning lamp. In an exhaust manifold overheat condition the maximum rpm will vary with the temperature of the manifold and could be limited to idle in extreme cases of overheating, a continuous horn will sound and the SC1000 will display a warning lamp.

IMPORTANT: Engine Guardian cannot guarantee that engine damage will not occur when adverse operating conditions are encountered. Engine Guardian is designed to warn the operator of an adverse condition and to reduce power by limiting rpm in an attempt to reduce possible engine damage. The boat operator is ultimately responsible for proper engine operation.

Typical Starting and Charging System Harness – Small Block MEFI 3

A - Audio Warning Components

1 - Oil Pressure Switch

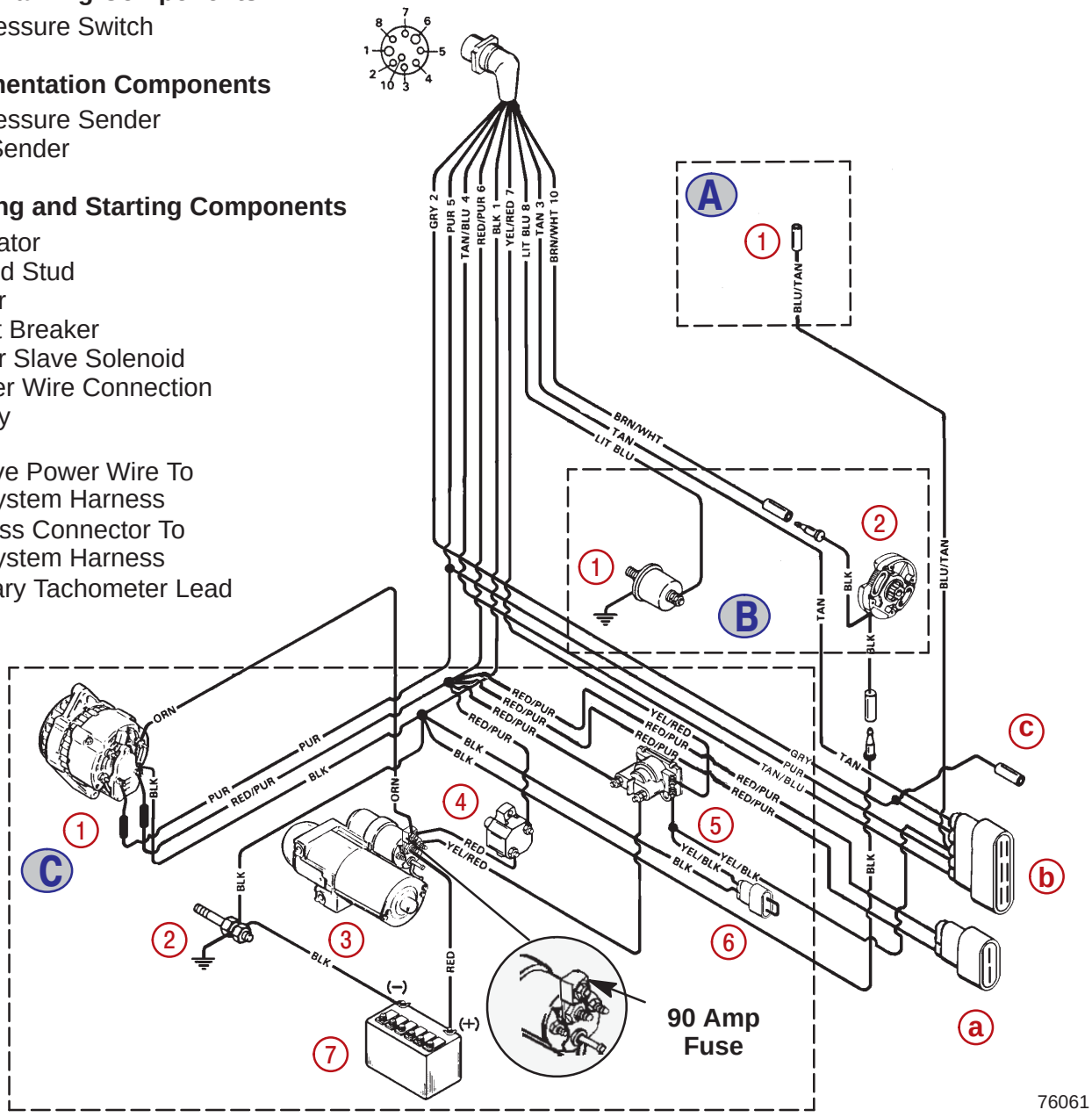
B - Instrumentation Components

1 - Oil Pressure Sender
2 - Trim Sender

C - Charging and Starting Components

1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid
6 - Jumper Wire Connection
7 - Battery

a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

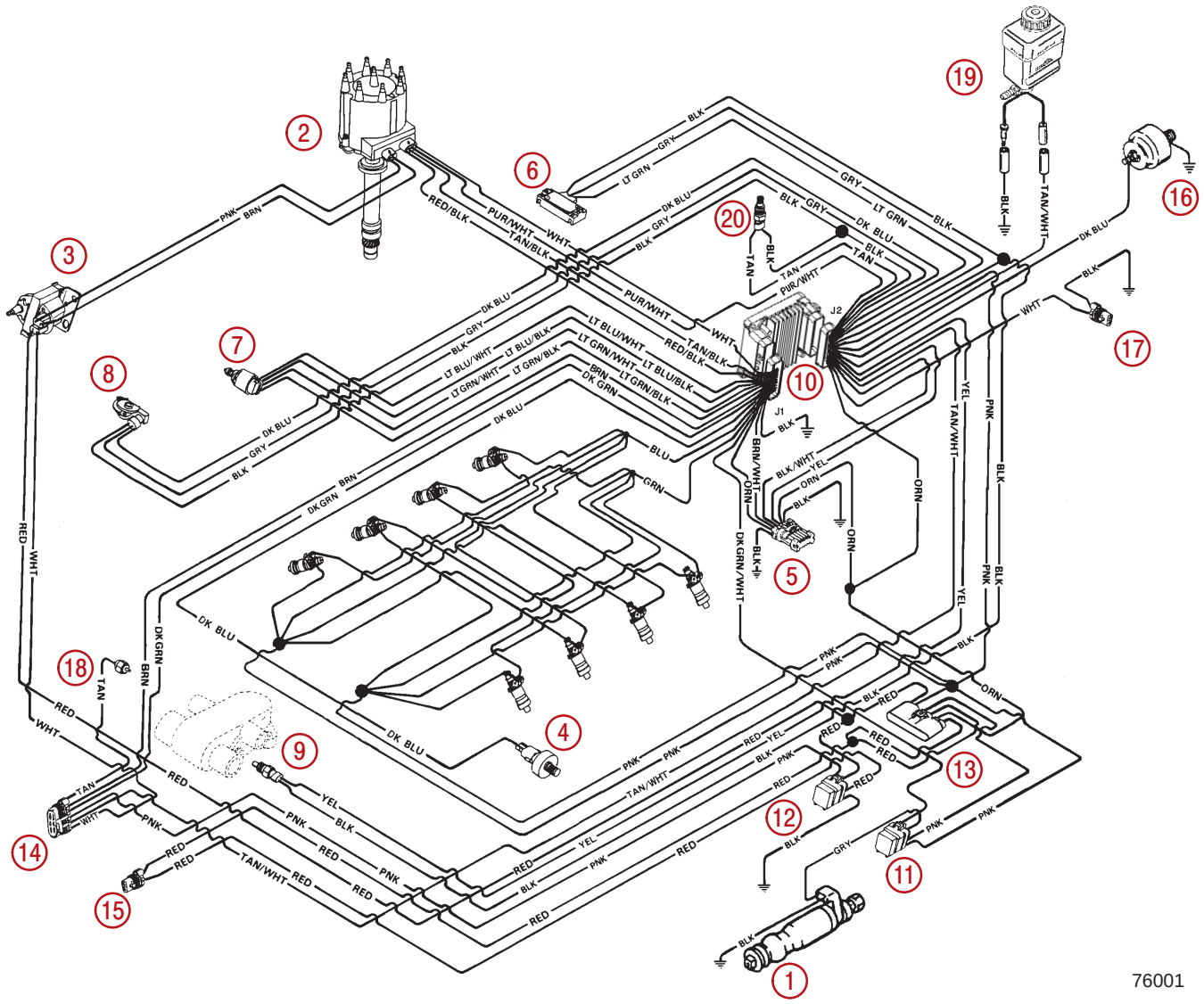


EFI System Harness – 454/502/8.2L Models (except L29) MEFI 3

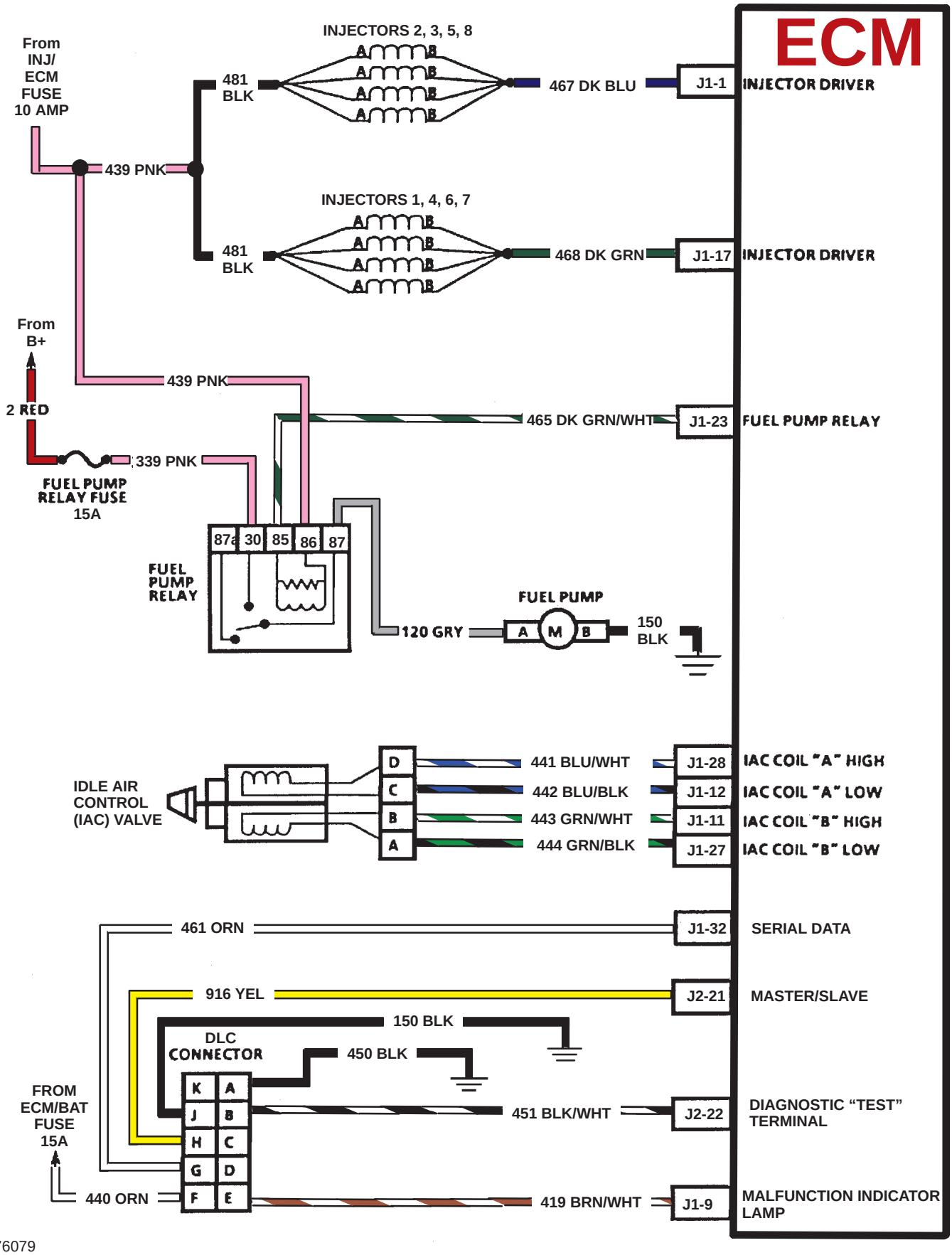
NOTE: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

NOTE: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*

1 - Fuel Pump
2 - Distributor
3 - Coil
4 - Knock Sensor (KS) Module
5 - Data Link Connector (DLC)
6 - Manifold Absolute Pressure (MAP) Sensor
7 - Idle Air Control (IAC)
8 - Throttle Position (TP) Sensor
9 - Engine Coolant Temperature (ECT) Sensor
10 - Electronic Control Module (ECM)
11 - Fuel Pump Relay
12 - Ignition/System Relay
13 - Fuses (15 Amp) Fuel Pump, (15 Amp) ECM / DLC / Battery, (10 Amp) ECM / Injector / Ignition / Knock Module
14 - Harness Connector To Starting/Charging Harness
15 - Positive (+) Power Wire To Engine Circuit Breaker
16 - Oil Pressure (Audio Warning System)
17 - Load Anticipation Circuit
18 - Water Temperature Sender
19 - Gear Lube Bottle (Not used on Inboard models)
20 - Intake Air Temperature (IAT) Sensor

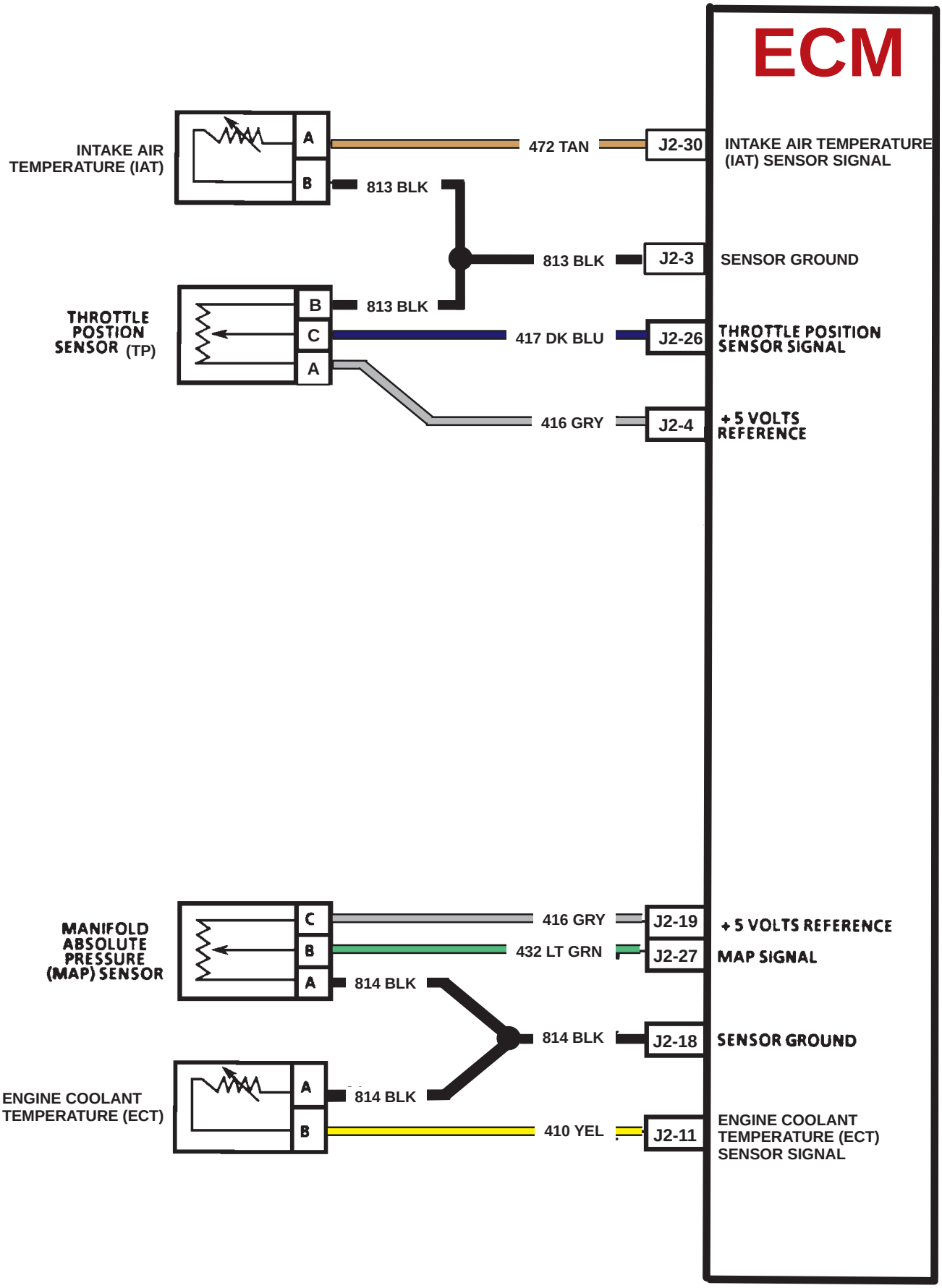


ECM Wiring Diagram - MEFI 3 (Big Block V8) (1 of 4)



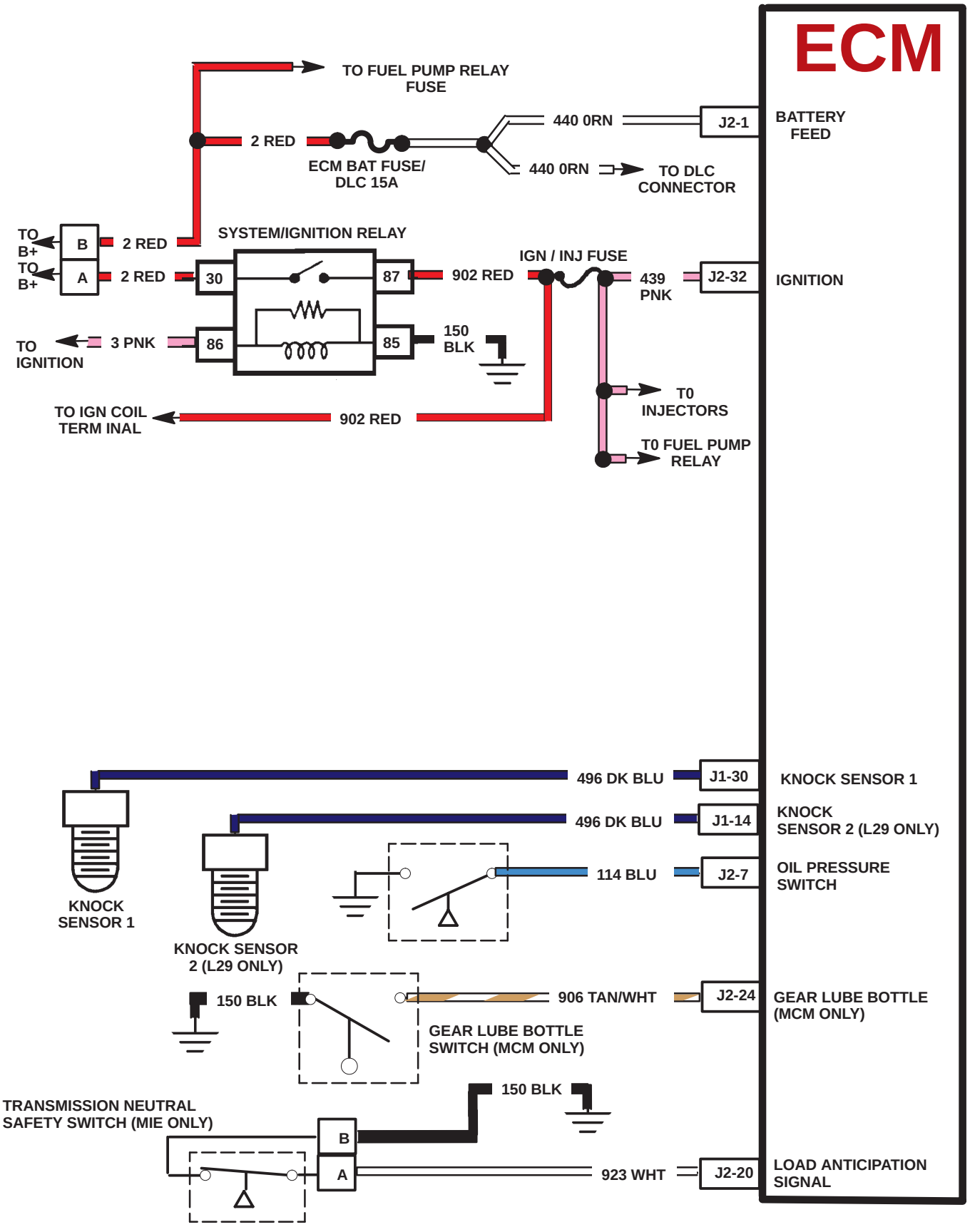
76079

ECM Wiring Diagram - MEFI 3 (Big Block V8) (2 of 4)



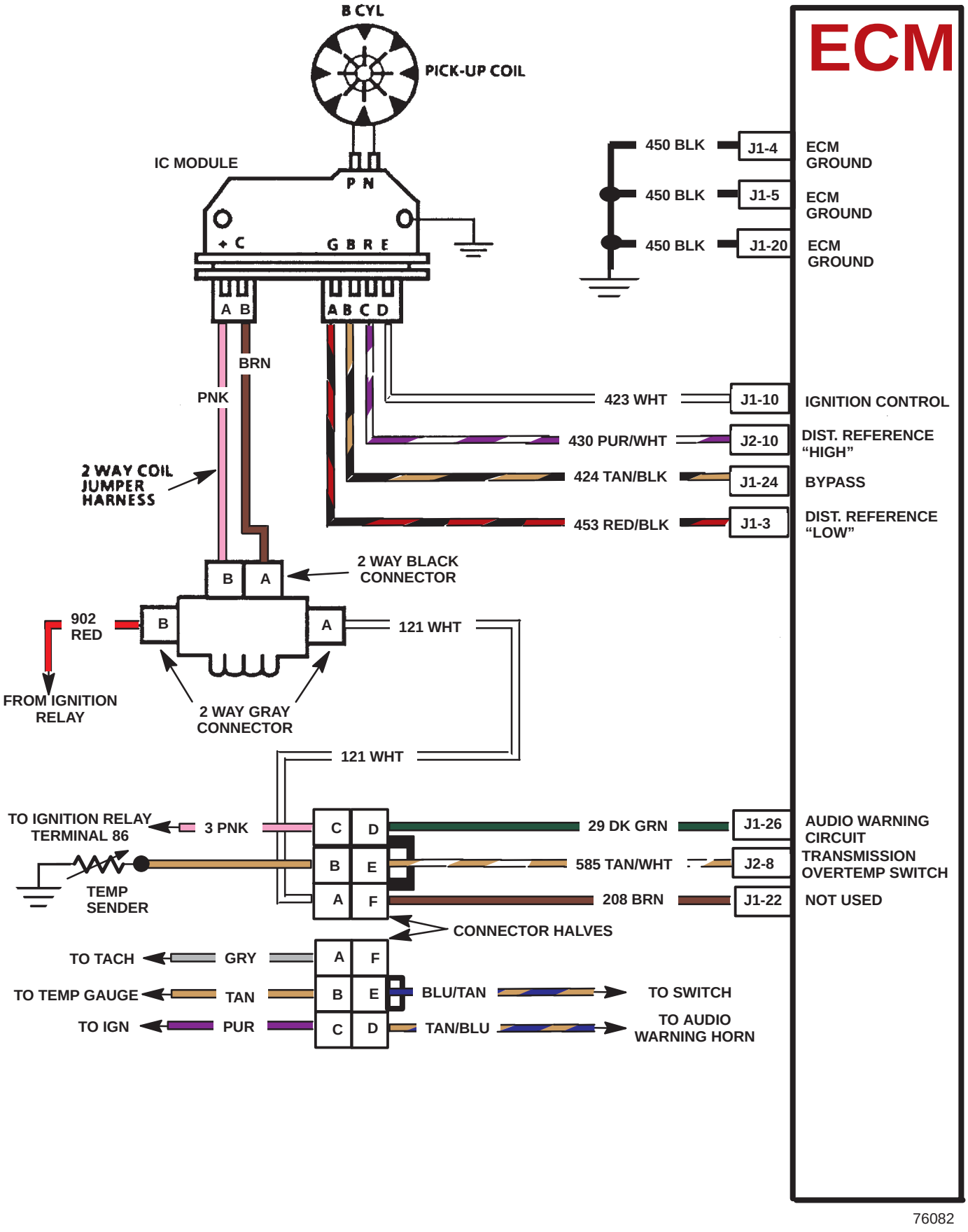
76080

ECM Wiring Diagram - MEFI 3 (Big Block V8) (3 of 4)

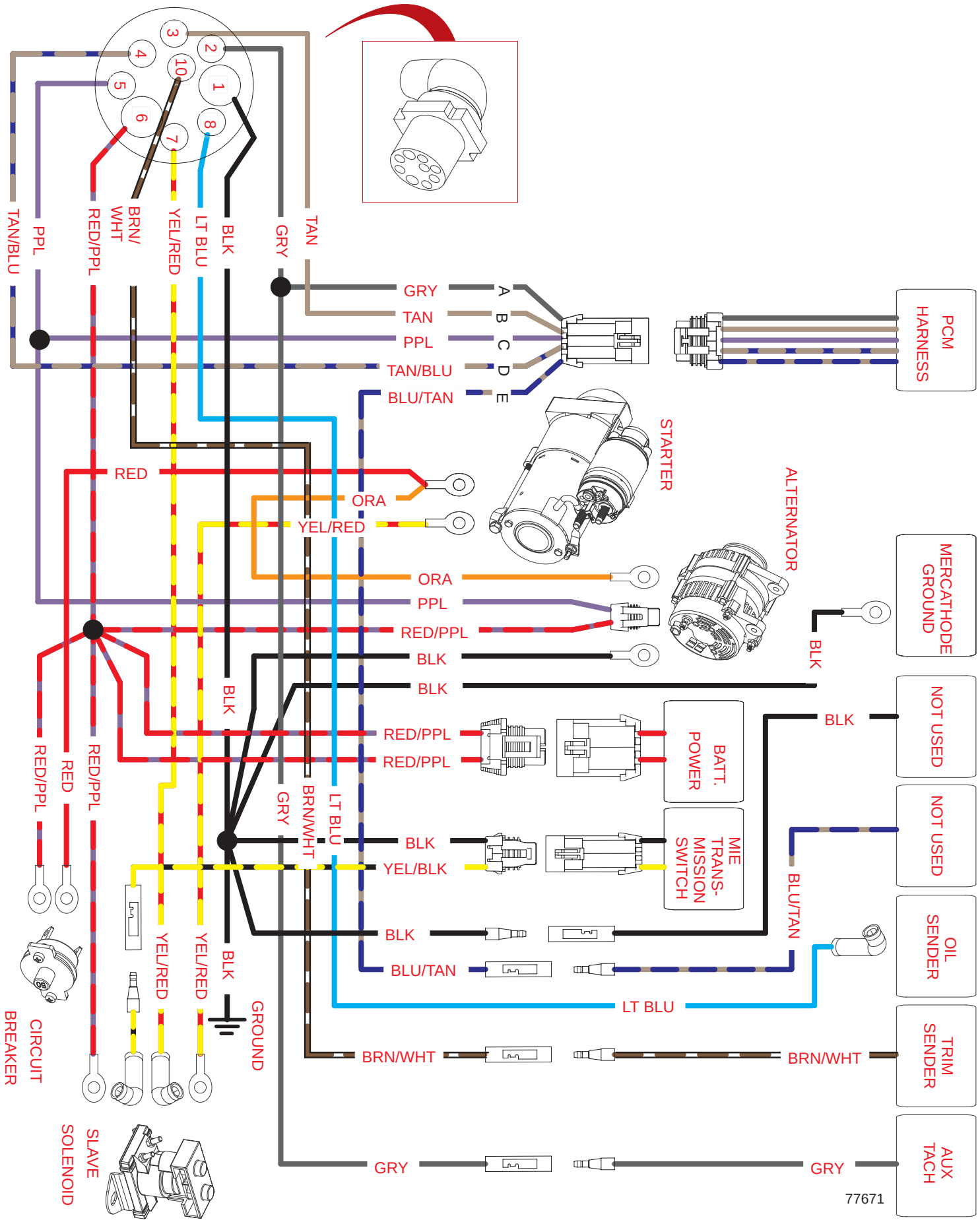


76081

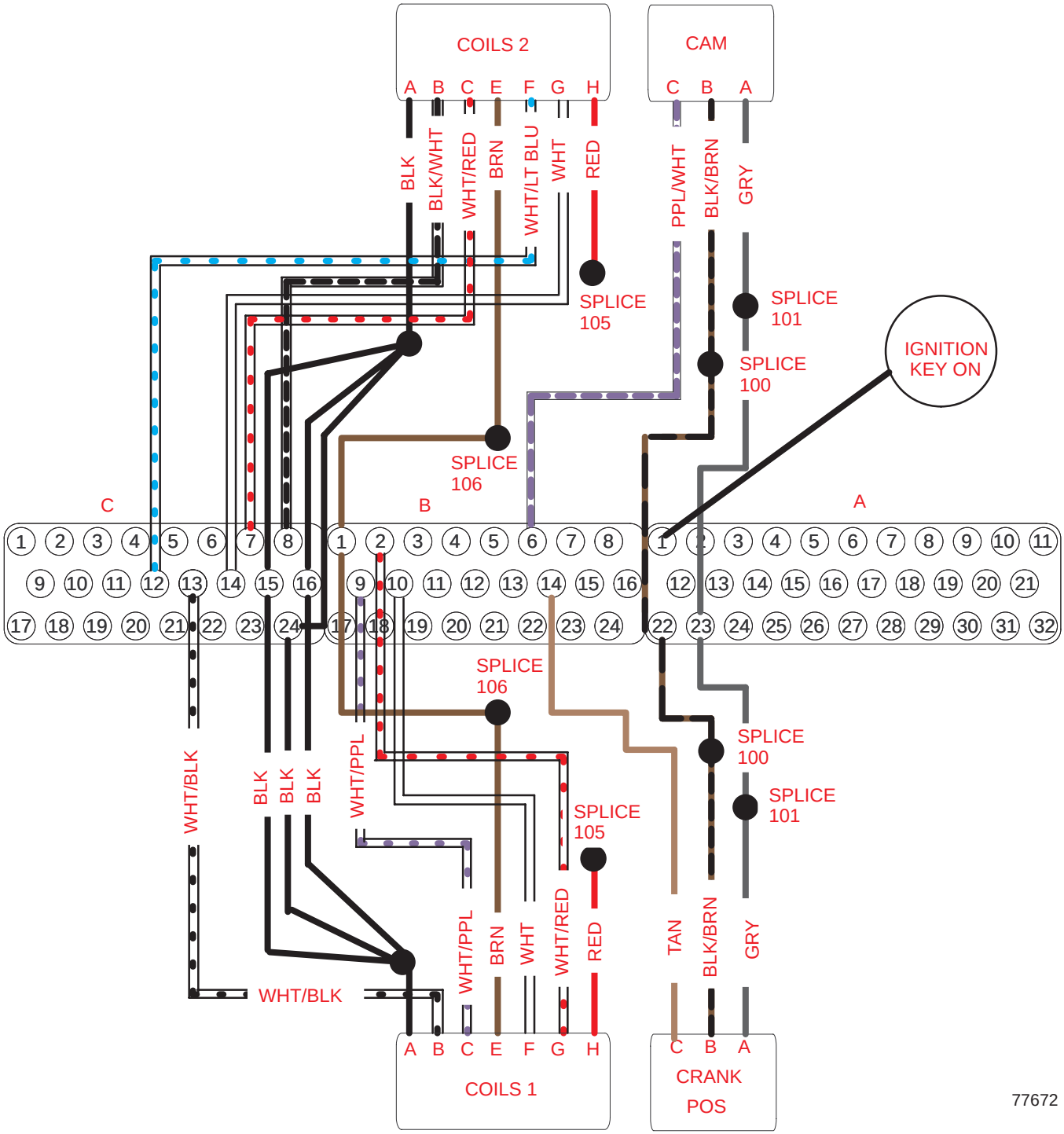
ECM Wiring Diagram - MEFI 3 (Big Block V8) (4 of 4)



PCM 555 – Charging Harness



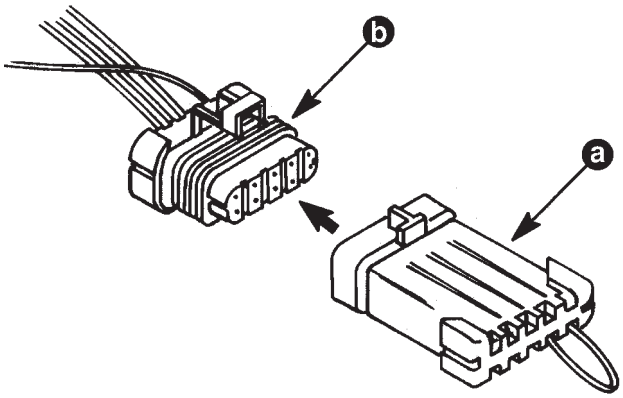
PCM 555 – Ignition Circuit



With initial key ON, 12 volt power is sent from the battery through the purple lead in the 10-pin harness to the pink lead at Engine Harness Pin C. This is wake up power to the PCM. The PCM powers pin B4 which in turn pulls the MPR low. The MPR powers the coils through Splice 105 and powers the engine for ignition.

PCM Pinout	Cyl. Number	PCM Pinout	Cyl. Number	PCM Pinout	Cyl. Number
B2	1	C8	4	B9	7
C7	2	C13	5	C14	8
B10	3	C12	6		

P/N 91-805747A2 Timing Tool for MerCruiser EFI Engines



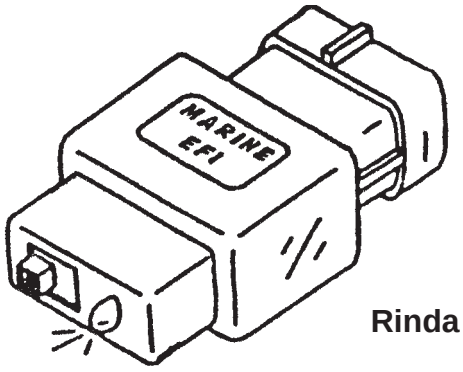
71839

a - Timing Tool
b - DLC Connector

CODEMATE™

Marine EFI Code Reader

CodeMate serves as both an EFI problem indicator and a spark timing service tool. The device connects to the DLC in a matter of seconds and alerts the boat owner or technician when EFI problems are detected. CodeMate allows diagnostic trouble codes (DTC's) to be read and when used with a timing light, allows the technician to verify/set the base ignition timing.



Rinda #94008

Available from:

Rinda Technologies, Inc. Chicago, IL
Telephone: (773) 736-6633
Fax: (773) 736-2950

Scan Tools

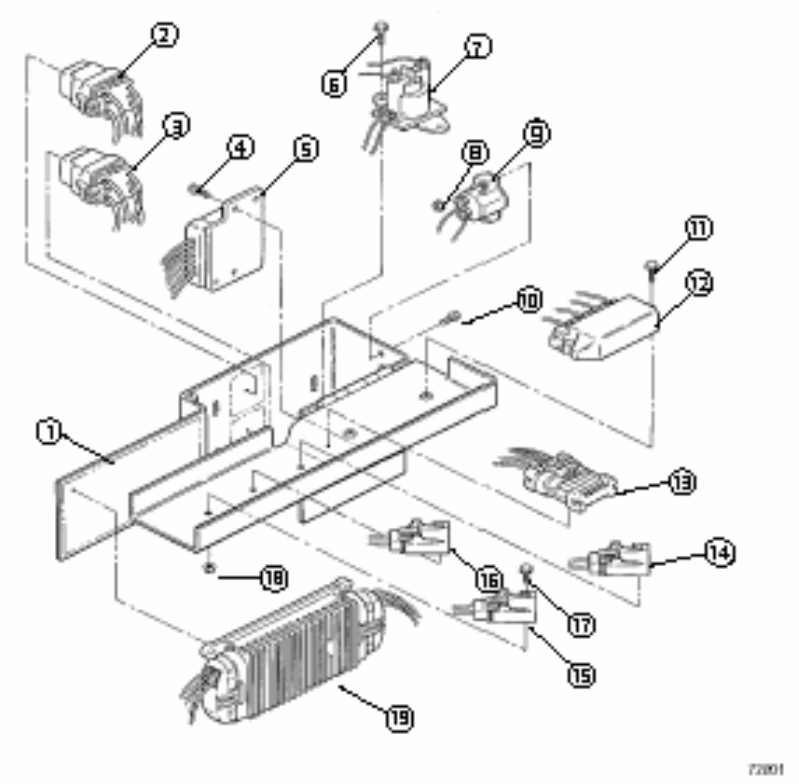
Older Software and Newer EFI Systems

Older scan tool software for the Quicksilver Digital Diagnostic Terminal (DDT) and MerCruiser/Rinda scan tools will not be able to read the information coming out of the newer ECM's. If you try to use the older software you will get an "error" message on the display of the DDT scan tool and you will get incorrect information from a MerCruiser/Rinda scan tool.

Test Tool Data Link Connector (DLC) Locations

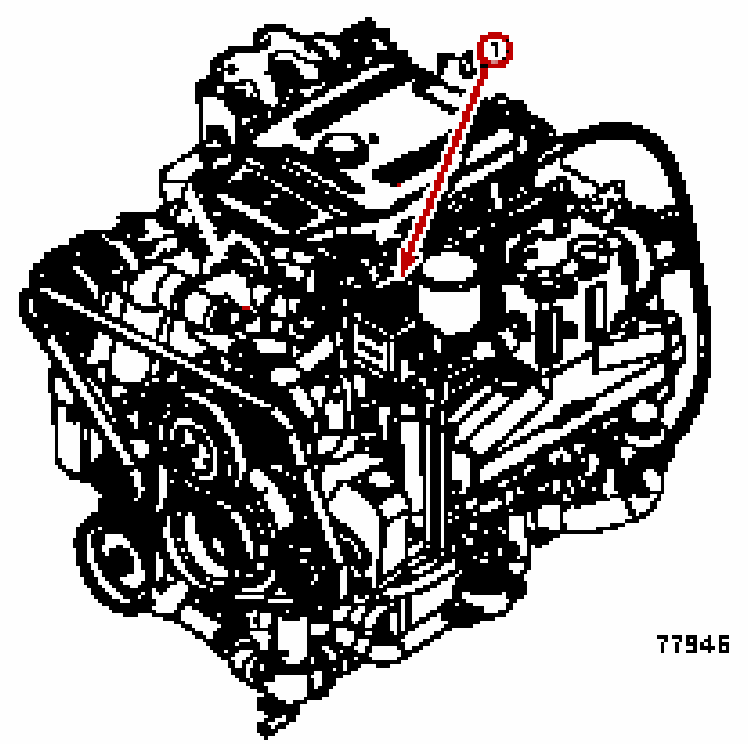
MEFI Systems

1 - Electrical Bracket
2 - Relay
3 - Relay
4 - Screw
5 - Knock Sensor (KS) Sensor
6 - Screw
7 - Slave Solenoid
8 - Nut
9 - Circuit Breaker
10- Screw
11- Screw
12- MerCathode
13- Data Link Connector (DLC)
14- Circuit Breaker Fuse
15- Circuit Breaker Fuse
16- Circuit Breaker Fuse
17- Screw
18- Nut
19- Engine Control Module (ECM)



ECM / PCM Systems

1 – Data Link Connector (DLC)



MERCURY MerCruiser **service bulletin**

No. 2001-2

☐ WARRANTY INFORMATION ☑ SERVICE INFORMATION

This bulletin replaces bulletin 96-4. Destroy that older bulletin.

Quicksilver DDT Scan Tool

Models

Mercury/Mariner EFI, DFI, Optimax, 3.0L Carb and 25-40 hp 4-cycle Outboards.

Mercury Racing EFI Outboards and MerCruisers.

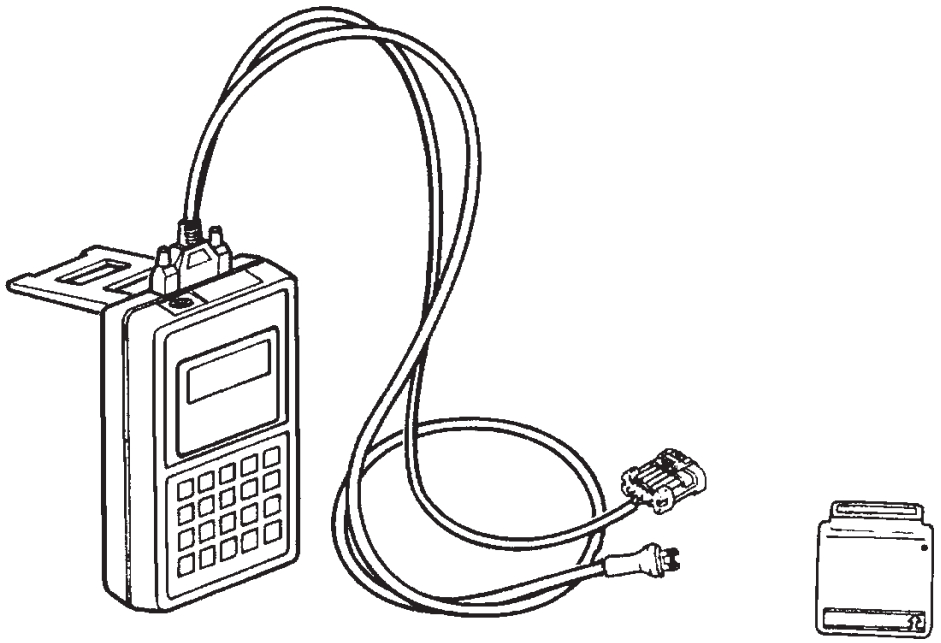
MerCruiser EFI and MPI Models including PCM 555.

MerCruiser 1997 and Newer Carb Models with Thunderbolt V Ignition System.

Digital Diagnostic Terminal (DDT) and Cartridge

This hand held Scan Tool is easy to use. The flexible sealed keypad, rubber boot and rugged design will provide many years of service. It comes with a 10-foot (3 m) cable. Adapter cables are used to connect the DDT to Data Link Connector (DLC) on the engine. There are separate Cartridges for Mercury/Mariner Outboards and MerCruiser products. Instructions with the Cartridges and Service Manuals will tell how to connect the DDT to the engine.

The DDT, when used with the correct cartridge, and the product's Service Manual will allow the technician to properly diagnose and repair engine systems. Engine functions can be monitored while the engine is running to aid in diagnosis and will display any stored trouble codes. On MerCruiser engines, the DDT is used to set the base engine timing on MEFI-1/-2/-3 ECM models.



75722

Ordering

DDT Scan Tool	
91-823686A 2	Digital Diagnostic Terminal (DDT)
Mercury/Mariner Outboard Cartridges	
91-822608 6	v5.0 – For non-PCM 555 Outboards.
91-880118 1	v1.1 – For PCM 555 Outboards. (Used on MerCruiser also).
Mercury/Mariner Outboard Adapter Harnesses	
84-822560A 1	1994 3.0L Carb Engines.
84-822560A 5	1994-1/2 and up 2.5L EFI (with 824003 ECM only). 1994-1/2 Pro Max/Super Max/Super Magnum. 1997 and up DFI/OptiMax Outboards.
84-822560A 6	1995 and up 3.0L EFI and Carb Outboards. (Use with 84-822560A 7).
84-822560A 7	1995 and up 3.0L EFI and Carb Outboards. (Use with 84-822560A 6).
84-822560A 8	All Hi-Performance 2.0L/2.5L EFI Outboards (with 11350A ECM only). (Use with 84-822560A 7).
84-822560A10	25-40 hp 4-cycle Outboards. (Use with 84-822560A 7).
84-822560T11	Extension Harness, 2-pin 15 ft (4.57 m) long. (Use with 84-822560A 5).
84-875232T 1	2000 Digital OptiMax Outboards only. ‘This T’ Harness allows the DDT to be connected under the dash at the 5-pin tachometer harness outlet.
Mercury/Mariner Outboard Injector Test Harnesses	
84-830043A 1	1986 and up 2.4L/2.5L/3.0L EFI Outboards. (Use with 84-822560A 7). 1982 and up Hi-Performance 2.0L/2.4L/ 2.5L/3.4L EFI Outboards. (Use with 84-830043A 2).
84-830043A 2	1982 and up Hi-Performance 2.0L/2.4L/2.5L/3.4L EFI Outboards (including Offshore models). (Use with 84-830043A 1).
MerCruiser Cartridges	
91-803999	v2.0 – For MEFI-1/-2/-3 ECM models. (Can also read RPM history on 1997 and up Thunderbolt V ignition modules).
91-880118 1	v1.1 – For PCM 555 models. (Used on Outboards also).

MerCruiser Adapter Harnesses

84-822560A 2	For MEFI-1/-2/-3 ECM models.
84-822560T12	For PCM 555 models (adapts 4-pin MerCruiser connector to 2-pin 84-822560A 5 Outboard harness).
	OR
84-822560A13	For PCM 555 models (4-pin connectors, no additional harness required).
84-861540A 1	1997 and up V6 and V8 Carb Engines with Thunderbolt V Ignition. Allows rpm history stored in Ignition Module to be read. (Use with 84-822560A 7).

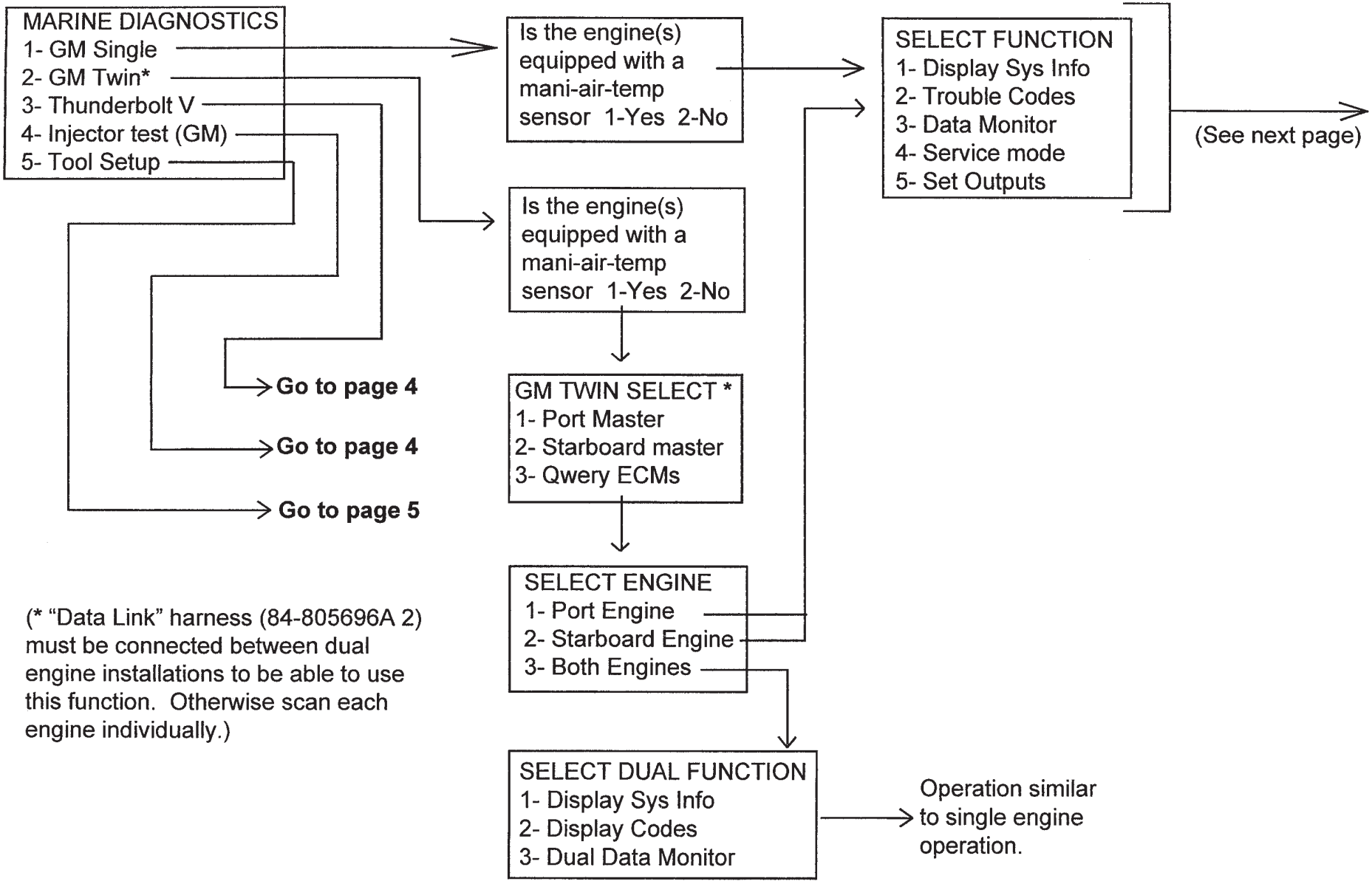
DDT Accessories

84-825003A 1	Replacement 10 ft. (3 m) 25-pin Harness for DDT.
91-804805	Heavy Duty Carrying Case for DDT.

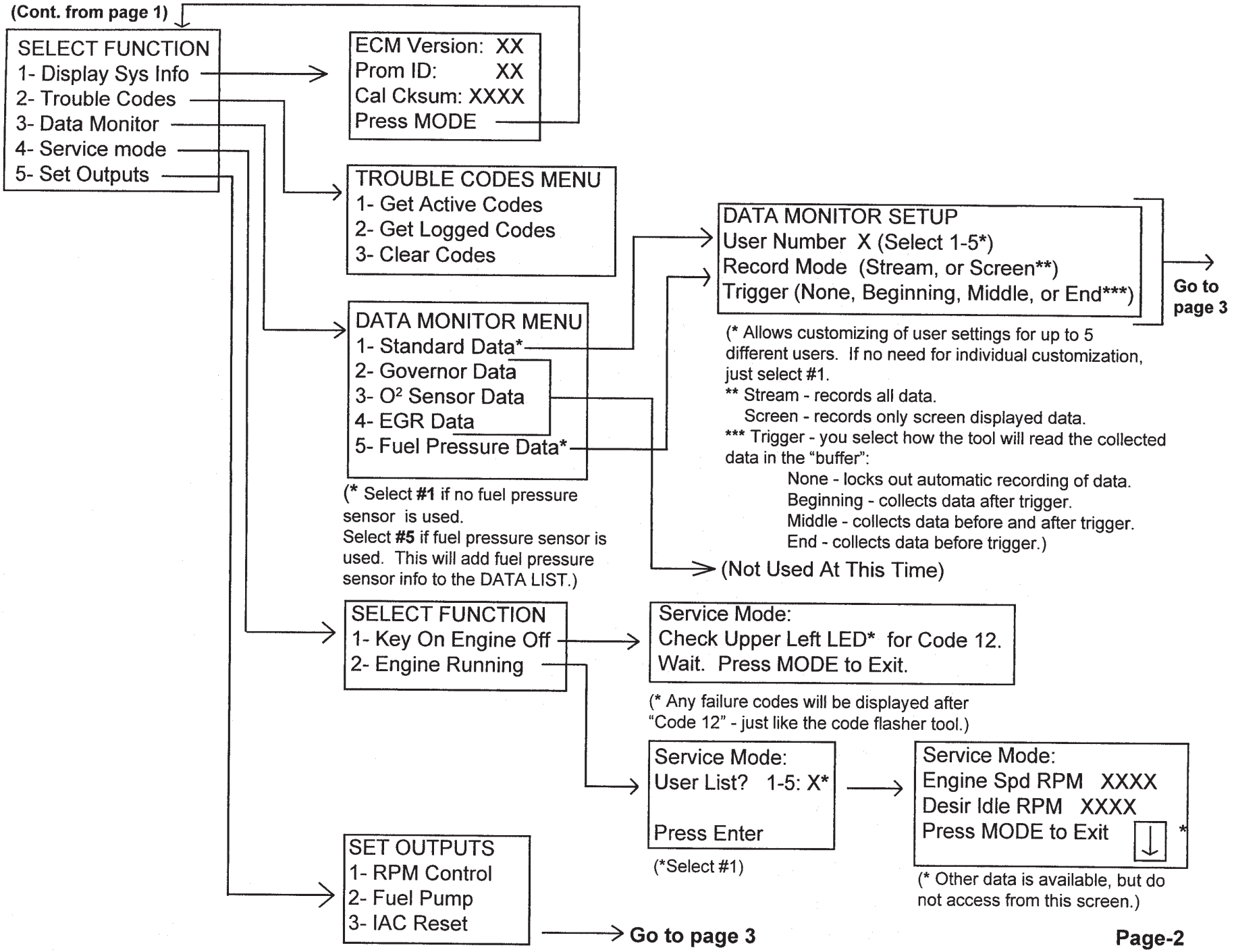
Not sold by Mercury Marine. Order these parts from Owantonna Tool Company.

USA And Canada:	Phone 800.328.6657	Fax 800. 578.7375
International:	Phone 810.578.7247	Fax 810.578.7321
Website: www.spx.com		
OTC P/N 3305-30	Replacement Rubber Protector Boot for DDT.	
OTC P/N 3285	Hard Copy Printer (12v, use with P/N 212536 cable).	
OTC P/N 212535	PC Adaptor Cable (9-pin).	
OTC P/N 212536	PC Adaptor Cable (25-pin).	

DDT MerCruiser Ver. 2.0 - MEFI 3, 502 Mag.



(* "Data Link" harness (84-805696A 2) must be connected between dual engine installations to be able to use this function. Otherwise scan each engine individually.)


(Cont. from page 1)
SELECT FUNCTION
1- Display Sys Info
2- Trouble Codes
3- Data Monitor
4- Service mode
5- Set Outputs
ECM Version: XX
Prom ID: XX
Cal Cksum: XXXX
Press MODE
TROUBLE CODES MENU
1- Get Active Codes
2- Get Logged Codes
3- Clear Codes
DATA MONITOR MENU
1- Standard Data*
2- Governor Data
3- O2 Sensor Data
4- EGR Data
5- Fuel Pressure Data*
(* Select #1 if no fuel pressure sensor is used.
Select #5 if fuel pressure sensor is used. This will add fuel pressure sensor info to the DATA LIST.)
DATA MONITOR SETUP
User Number X (Select 1-5*)
Record Mode (Stream, or Screen**)
Trigger (None, Beginning, Middle, or End***)
Go to page 3
(* Allows customizing of user settings for up to 5 different users. If no need for individual customization, just select #1.
** Stream - records all data.
Screen - records only screen displayed data.
*** Trigger - you select how the tool will read the collected data in the "buffer":
None - locks out automatic recording of data.
Beginning - collects data after trigger.
Middle - collects data before and after trigger.
End - collects data before trigger.)
(Not Used At This Time)
SELECT FUNCTION
1- Key On Engine Off
2- Engine Running
Service Mode:
Check Upper Left LED* for Code 12.
Wait. Press MODE to Exit.
(* Any failure codes will be displayed after "Code 12" - just like the code flasher tool.)
Service Mode:
User List? 1-5: X*
Press Enter
(*Select #1)
Service Mode:
Engine Spd RPM XXXX
Desir Idle RPM XXXX
Press MODE to Exit
*
(* Other data is available, but do not access from this screen.)
SET OUTPUTS
1- RPM Control
2- Fuel Pump
3- IAC Reset
Go to page 3

(Cont. from page 2)

DATA MONITOR SETUP
User Number X (Select 1-5*)
Record Mode (Stream, or Screen**)
Trigger (None, Beginning, Middle, or End***)

→ Select "None" → DATA LIST

* See data list per sheet. Select 4. Press #1-4 on keypad to lock choices on screen. Scroll thru list on screen to make selections. When item is "locked" in the first letter in line is underlined.

Press [R] to start recording, and again to stop recording. Records until data buffer is full (13-30 sec.).

→ Select "B, M, or E" → TRIGGER MODE
Manual, or Fault →

(Cont. from page 2)

SET OUTPUTS
1- RPM Control
2- Fuel Pump
3- IAC Reset

Adjust RPM: XXXX *
Engine Spd RPM XXXX
Desir Idle RPM XXXX **
Press MODE to Exit

(*Press Left, or Right arrows to lower, or raise RPM. IAC is being manually controlled to raise, or lower idle RPM. Checks IAC function.
** Other data is available, but use caution as some data will be affected by being in this RPM control mode.)

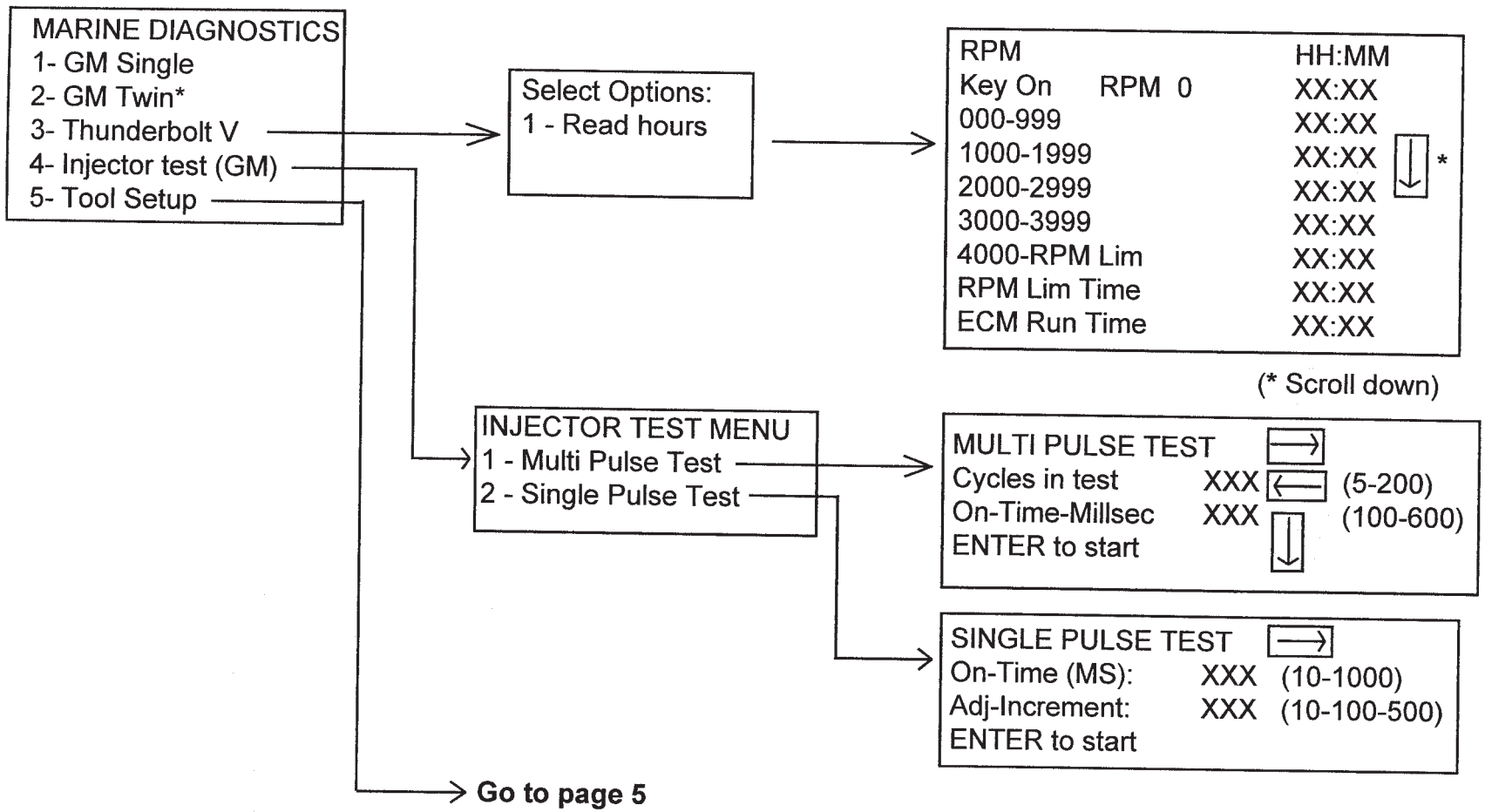
Fuel System Prime
Pump Off
[←] [→] To Toggle State
Press MODE to Exit

IAC Reset * Off
Engine Spd RPM XXX
Desir Idle RPM XXX **
Press MODE to exit

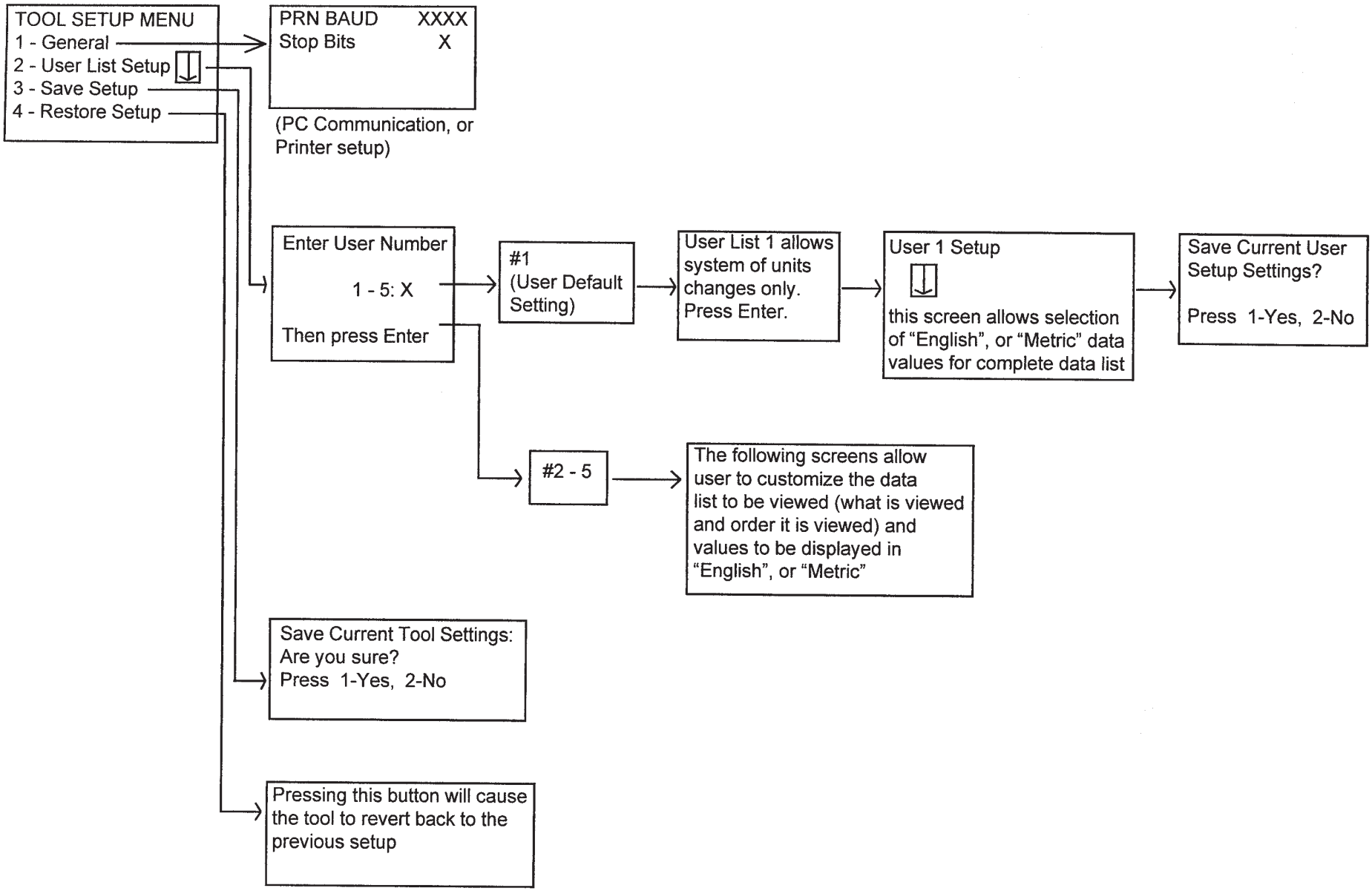
(* Press Left, or Right arrows to reset IAC.
** Other data is available, but use caution, as some data may be affected by being in the IAC reset mode.)

Note: Check to see if IAC is functioning by hitting Reset and then feel case of IAC for vibration.

(Cont. from page 1)



(Cont. from page 1)


TOOL SETUP MENU
1 - General
2 - User List Setup
3 - Save Setup
4 - Restore Setup
PRN BAUD XXXX
Stop Bits X
(PC Communication, or Printer setup)
Enter User Number
1 - 5: X
Then press Enter
#1 (User Default Setting)
User List 1 allows system of units changes only. Press Enter.
User 1 Setup
this screen allows selection of "English", or "Metric" data values for complete data list
Save Current User Setup Settings?
Press 1-Yes, 2-No
#2 - 5
The following screens allow user to customize the data list to be viewed (what is viewed and order it is viewed) and values to be displayed in "English", or "Metric"
Save Current Tool Settings: Are you sure?
Press 1-Yes, 2-No
Pressing this button will cause the tool to revert back to the previous setup

MEFI 1 Data Log Sheet (DDT)

MERCURY Tech Service Education

Engine Model: _____ Serial Number: _____

Customer/RO#: _____ Test RPM/conditions: _____

Data Item (english units)	Current Reading:	Comments:
Engine Speed Rpm	_____	_____
Desired Engine Rpm	_____	_____
ECT Sensor (F)	_____	_____
IAT Sensor (F)	_____	_____
Map Sensor (Hg)	_____	_____
Map Sensor V	_____	_____
Baro Sensor (Hg)	_____	_____
Baro Sensor V	_____	_____
TP Sensor V	_____	_____
TP Sensor %	_____	_____
Fuel Rate (Gph)	_____	_____
Inj. Pulse Width (ms)	_____	_____
Spark Advance	_____	_____
KS System Enabled	_____	_____
KS Signal	_____	_____
Knock Retard	_____	_____
IAC Position	_____	_____
Base IAC Position	_____	_____
Trim Sensor V	Not used by MC	_____
IAC Follower	_____	_____
Vessel Speed (MPH)	Not used by MC	_____
Battery V	_____	_____
Fuel Pump Relay	_____	_____
Power Reduction	_____	_____
Overheat Detection	_____	_____
Low Oil Pressure Switch	_____	_____
Low Oil Level Switch	Not used by MC	_____
Low Water Flow Switch	Not used by MC	_____
Trans Temp Switch	Not used by MC	_____
I/O Fluid Level	Not used by MC	_____
Gen Warn 1: Lamp	Not used by MC	_____
Buzzer	_____	_____
Lanyard Stop	_____	_____
Overtrim Detection	Not used by MC	_____
ECM Status	_____	_____
Fuel System	Not used by MC	_____
Engine Hours (total)	_____	_____
Run Time (current run event)	_____	_____

MEFI 2 Data Log Sheet (DDT)

MERCURY Tech Service Education

Engine Model: _____ Serial Number: _____

Customer/RO#: _____ Test RPM/conditions: _____

Data Item (english units)	Current Reading:	Comments:
Engine Speed Rpm	_____	_____
Desired Engine Rpm	_____	_____
ECT Sensor (F)	_____	_____
IAT Sensor (F)	_____	_____
Map Sensor (Hg)	_____	_____
Map Sensor V	_____	_____
Baro Sensor (Hg)	_____	_____
Baro Sensor V	_____	_____
TP Sensor V	_____	_____
TP Sensor %	_____	_____
Fuel Rate (Gph)	_____	_____
Inj. Pulse Width (ms)	_____	_____
Spark Advance	_____	_____
KS System Enabled	_____	_____
KS Signal	_____	_____
Knock Retard	_____	_____
IAC Position	_____	_____
Base IAC Position	_____	_____
Shift Interrupt	_____	_____
IAC Follower	_____	_____
Battery V	_____	_____
Fuel Pump Relay	_____	_____
Power Reduction	Not used by MC	_____
Overheat Detection	_____	_____
Low Oil Pressure Switch	_____	_____
Low Oil Level Switch	Not used by MC	_____
Low Oil Lamp	Not used by MC	_____
General Warning 1	_____	_____
General Warning 2	_____	_____
General Warning 1: Lamp	Not used by MC	_____
Buzzer	_____	_____
Lanyard Stop	Not used by MC	_____
Check Gauge Lamp	Not used by MC	_____
ECM Status	_____	_____
Fuel System	Not used by MC	_____
Engine Hours (total)	_____	_____
Run Time (current run event)	_____	_____

MEFI 3 Data Log Sheet (DDT)

MERCURY Tech Service Education

Engine Model: _____ Serial Number: _____

Customer/RO#: _____ Test RPM/conditions: _____

Data Item (english units)	Current Reading:	Comments:
Engine Speed Rpm		
Desired Engine Rpm		
ECT Sensor (F)		
IAT Sensor (F)		
Map Sensor (Hg)		
Map Sensor V		
Baro Sensor (Hg)		
Baro Sensor V		
TP Sensor V		
TP Sensor %		
Fuel Rate (Gph)		
Inj. Pulse Width (ms)		
Spark Advance		
KS System Enabled		
KS Signal		
Knock Retard		
Knock 1		
Knock 2		
IAC Position		
Base IAC Position		
Shift Interrupt		
Troll Mode	Not used by MC	
Troll RPM Limit	Not used by MC	
IAC Follower		
Closed Throttle		
Vessel Speed (MPH)	Not used by MC	
Battery V		
Voltage Warning		
Fuel Pump Relay		
Cause Power Reduction	Not used by MC	
Power Reduction		
Overheat Detection		
Low Oil Pressure Switch		
Low Oil Level Switch	Not used by MC	
Low Oil Lamp	Not used by MC	

MEFI 3 Data Log Sheet (DDT) [cont.]

Data Item (english units)	Current Reading:	Comments:
General Warning 1	_____	_____
General Warning 2	_____	_____
General Warning 1: Lamp	Not used by MC	_____
General Warning 2: Lamp	Not used by MC	_____
Buzzer	_____	_____
Lanyard Stop	_____	_____
Check Gauge Lamp	Not used by MC	_____
RPM Base Out	Not used by MC	_____
ECM Status	_____	_____
Fuel System	Not used by MC	_____
Engine Hours (total)	_____	_____
Run Time (current run event)	_____	_____

PCM 555/03 and ECM 555 Data Log Sheet (DDT)

Engine Model: _____ Serial Number: _____

Customer/RO#: _____ Test RPM/conditions: _____

Type exhaust: _____ Prop type and pitch: _____

Altitude: _____ Calibration #: _____

Ambient Temperature: _____ Sea/Lake/River Temperature: _____

Data Item (english units)	**Current Reading:**	**Comments:**
Engine RPM	_____	_____
Battery Volts	_____	_____
PWR 1 Volts	_____	_____
PWR 2 Volts	_____	_____
MAP PSI	_____	_____
Fuel Level	_____	_____
Available PWR %	_____	_____
Shift (ECM 555 only)	_____	_____
Trim	_____	_____
Pitot	_____	_____
Paddle Wheel	_____	_____
Lake/Sea Temp °F	_____	_____
IAC PWM %	_____	_____
Spark Ang B/ATDC	_____	_____
Baro PSI	_____	_____
STB EMCT °F (PCM only)	_____	_____
Port EMCT °F (PCM only)	_____	_____
Oil PSI	_____	_____
ECT °F	_____	_____
Sea Pump PSI	_____	_____
TPS 1 Volts	_____	_____
TPS %	_____	_____
MAT °F	_____	_____
FPC Total oz (PCM only)	_____	_____

MERCURY MerCruiser **service bulletin**

No. 2001-1

☐ **WARRANTY INFORMATION** ☑ **SERVICE INFORMATION**

This bulletin replaces bulletins 96-9 and 93-23. Destroy these older bulletins.

MerCruiser/Rinda Scan Tool

Models

All MCM/MIE EFI (TBI) and MPI Gasoline Models.

All MCM/MIE 496/8.1L PCM 555 MPI Gasoline Models.

All 1997 and Newer MCM/MIE Carburetor Models with Thunderbolt V Ignition System.

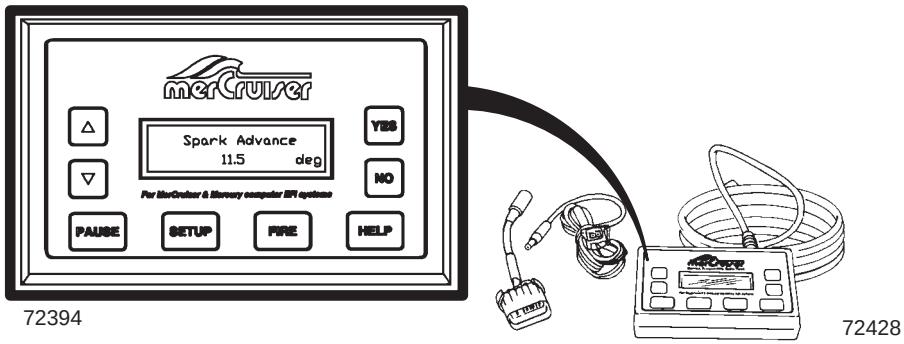
All MCM/MIE D-Tronic Diesel Models.

2001 Scan Tool, Version 4.0

This hand held Scan Tool has been updated for 2001. It can be used on all gasoline MCM/MIE engines equipped with either the Delco MEFI ECM or the new Mercury PCM 555. The tool will also monitor the MCM/MIE D-Tronic system used on diesel models. On carburetor engines with Thunderbolt V Ignition (1997 and newer), this Scan Tool can read rpm history stored in the ignition module. The tool is not able to troubleshoot the Thunderbolt V ignition system

Dealers that already own an earlier version of this scan tool can purchase the 2001 4.0 version update kit.

Technicians will also need a special 4 pin PCM 555 Adapter to connect the tool to the engine harness. This Adapter can be ordered separately or as a combined update kit including software.



72394 72428

Windows® PC Software Available

A completely new Diacom® Marine diagnostic package (not shown) is available for Windows 98, MF, NT and Windows 2000 equipped laptop computers. Diacom® Marine software allows a PC to function as a high performance scan tool capable of diagnostics. The software provide a live view of the engine sensor and control system information. Data can be viewed numerically, displayed graphically or saved on a disk for review off-line. The software is supplied with a special cable allowing the PC to connect to the engine's DLC. Diacom® Marine also provides instant access to electronic service information when it is available from the manufacturer.

Ordering New or Updating Older Scan Tools

English Language Update Kit: Instructions come with the kit and it takes about 10 minutes to install it.

International Update Kit: International dealers can order directly from Rinda. Instructions come with the kit and it takes about 10 minutes to install it.

New Scan Tools, Diacom® software, update kits and adapters are available directly from Rinda. The warranty on a new Scan Tool is for one year. Rinda can ship internationally. Prices shown do not include shipping cost. Rinda Technologies, Inc. will also be the repair facility for these Scan Tools.

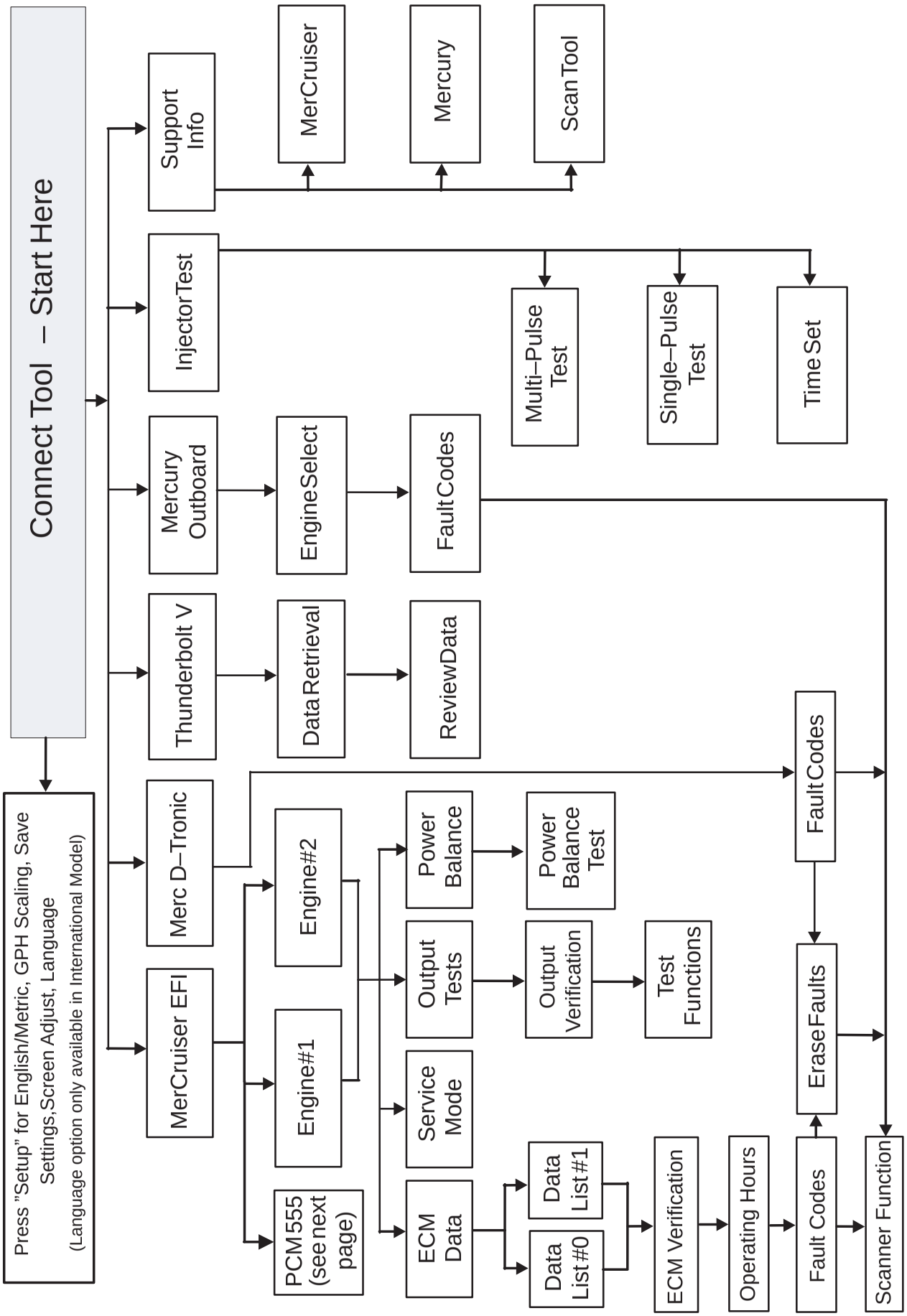
Rinda Technologies, Inc.
4563 N. Elston Ave.
Chicago, IL. 60630
Phone: 773.736.6633 E-Mail: sales@rinda.com
Fax: 773.736.2950 Website: www.rinda.com

Scan Tools with Carrying Case	**Part Number**
2001 4.0 Version English	94050m
2001 4.0 Version English/German	94055g
2001 4.0 Version English/Italian	94055i
2001 4.0 Version English/French	94055f
2001 4.0 Version English/Spanish	94055s
2001 4.0 Version English/Swedish	94055w

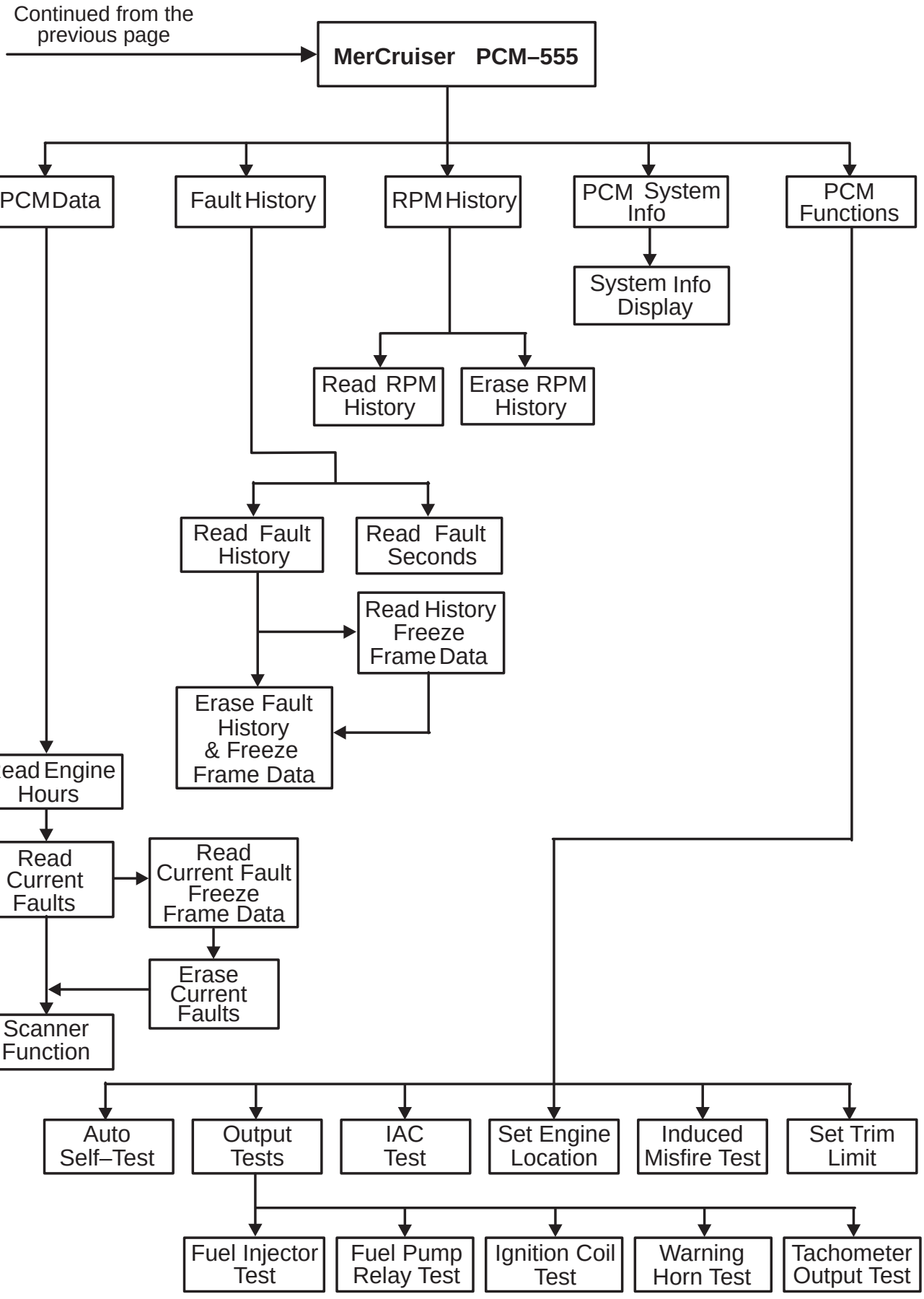
Scan Tool Software Update Kits (Includes P/N 94006 PCM 555 Adaptor)	**Part Number**
2001 4.0 Version English	94056
2001 4.0 Version English/German	94056g
2001 4.0 Version English/Italian	94056i
2001 4.0 Version English/French	94056f
2001 4.0 Version English/Spanish	94056s
2001 4.0 Version English/Swedish	94056w

Optional Scan Tool Adapters	**Part Number**
MerCruiser PCM 555 4 pin Adaptor	94006
MerCruiser Thunderbolt V Ignition Adapter	94020
D2.8L and D4.2L D-Tronic Diesel Adapter	94014
D7.3L D-Tronic Diesel Adapter	94021

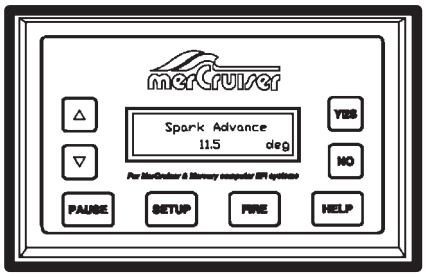
MerCruiser/Rinda Function Flowchart



MerCruiser/Rinda Function Flowchart (Continued)



MC/RINDA
MEFI I DATA SHEET



Engine Data Worksheet

Engine Type:_ Year:_____
Serial No.:_____
Contact:_____
Tel:_____ Fax:_____
Date:_____ / _____ / _

Gasoline EFI (MEFI I ECM)

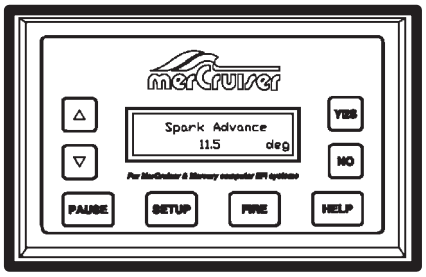
Scan tool requires adapter #94005 for this application

Scan Tool Data List #1

Data Item	Current Reading	Normal Reading	Comments
Engine Speed			
Des Idle Speed			
Coolant Temp			
Manifold Air Tmp			
TPS Volts			
Throttle Pct			
MAP Volts			
Manifold Pres			
Baro Volts			
Battery Volts			
Spark Advance			
Knock Retard			
IAC Position			
Base IAC Pos			
IAC Follower			
Injector ON Time			
Inj ON Time Crnk			
Fuel Flow Rate			
Engine Run Time			
Memcal Checksum			
Fault Switches			
Engine Overtemp			
Power Reduction			
E-Stop Status			

Rinda Technologies Inc. *Chicago, IL* *Tel: 773-736-6633*

MC/RINDA
MEFI II DATA SHEET



Engine Data Worksheet

Engine Type:_ Year:_____
Serial No.:_____
Contact:_____
Tel:_____ Fax:_____
Date:_____ / _____ / _

Gasoline EFI (MEFI II ECM)

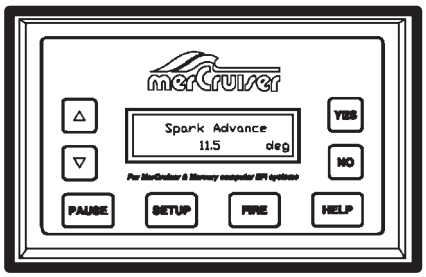
Scan tool requires adapter #94005 for this application

Scan Tool Data List #1

Data Item	Current Reading	Normal Reading	Comments
Engine Speed			
Des Idle Speed			
Coolant Temp			
Manifold Air Tmp			
TPS Volts			
Throttle Pct			
MAP Volts			
Manifold Pres			
Baro Volts			
Battery Volts			
Spark Advance			
Engine Knocking			
Knock Retard			
IAC Position			
Base IAC Pos			
IAC Follower			
Injector ON Time			
Fuel Flow Rate			
Engine Run Time			
Memcal Checksum			
Engine Overtemp			
Power Reduction			
Fault Switches			
Shift Interrupt			
E-Stop Status			
Diagnostic Input			
Input J1-20			
General Warn #1			
General Warn #2			
Fuel System			
Slave Input			
Fuel Pump Status			
Check Engine Lamp			

Rinda Technologies Inc. *Chicago, IL* *Tel: 773-736-6633*

MC/RINDA
MEFI III DATA SHEET



Engine Data Worksheet

Engine Type:_ Year:_____
Serial No.:_____
Contact:_____
Tel:_____ Fax:_____
Date:_____ / _____ / _

Gasoline EFI (MEFI III ECM)

Scan tool requires adapter #94005 for this application

Scan Tool Data List #1

Data Item	Current Reading	Normal Reading	Comments
Engine Speed			
Des Idle Speed			
Coolant Temp			
Manifold Air Tmp			
TPS Volts			
Throttle Pct			
MAP Volts			
Manifold Pres			
Baro Pres			
Battery Volts			
Spark Advance			
Engine Knocking			
Knock Retard			
IAC Position			
Base IAC Pos			
IAC Follower			
Injector ON Time			
Fuel Flow Rate			
Engine Run Time			
Calibration ID			
Memcal Checksum			
Engine Overtemp			
Power Reduction			
Rev Limiter			
Input J2-9			
E-Stop Status			
Diagnostic Input			
Low Oil Level			
Oil Level Lamp			
General Warn #1			
General Warn #2			
Input J2-20			
Fuel Pump Status			
Check Engine Lamp			
Check Gauge Lamp			
RPM Ctrl Output			

Rinda Technologies Inc. *Chicago, IL* *Tel: 773-736-6633*

PCM/ECM 555 Data Log Sheet (Rinda Scan Tool)

Engine Model: _____ Serial Number: _____

Customer/RO#: _____ Test RPM/conditions: _____

Type exhaust: _____ Prop type and pitch: _____

Altitude: _____ PCM/ECM Calibration #: _____

Ambient Temperature: _____ Sea/Lake/River Temperature: _____

Data Item (english units)	**Current Reading:**	**Comments:**
Engine Speed Rpm	_____	_____
Fuel Flow Rate (gph)	_____	_____
Lake/Sea Temp (F)	_____	_____
Paddle Wheel (Hz)	_____	_____
Pitot ADC	_____	_____
Trim Position	_____	_____
Trim Volts	_____	_____
Fuel Level	_____	_____
Available Power %	_____	_____
Sensor Power (VDC)	_____	_____
Battery Volts	_____	_____
Port Exhst Temp (F)*	_____	_____
Stbd Exhst Temp (F)*	_____	_____
Sea Pump Pres (psi)	_____	_____
Spark Advance (deg)	_____	_____
Oil Pressure (psi)	_____	_____
IAC Duty Cycle (%)	_____	_____
TPS #1 Position (%)	_____	_____
TPS #1 Volts	_____	_____
Manifold Air Temp (F)	_____	_____
Barometric Pressure (psi)	_____	_____
Manifold Pressure (psi)	_____	_____
Coolant Temp (F)	_____	_____

(***** Not used on ECM555 models – a default value will be displayed.)

MERCURY MerCruiser

Service Bulletin

☐ Warranty Information ☑ Service Information Bulletin No. 2004-04
☐ Parts Information OEM No. 2004-02

Circulate to: ☐ Sales Manager ☐ Accounting ☑ Service Manager ☑ Technician ☑ Parts Manager

Computer Diagnostic System

Models Affected

MerCruiser*

Models Covered	Serial Number Or Year
MCM/MIE MEFI, EFI (TBI) and MPI Gasoline Models	All Models
MCM/MIE PCM/ECM 555 or PCM 03 Gasoline Models	All Models

Mercury/Mariner Outboards*

Models Covered	Serial Number Or Year
OptiMax with PCM 555 or PCM 03	2001-1/2 and up
EFI with PCM 555 or PCM 03	2002
30/40/50/60 EFI FourStroke with ECM 555	2002 and up

Jet Drives*

Models Covered	Serial Number Or Year
200 DFI	All Models
240 EFI with PCM 555	All Models

Mercury Racing*

Models Covered	Serial Number Or Year
Outboards with PCM 555 or PCM 03	All Models
MerCruiser Models with MEFI Fuel Injection	All Models
MerCruiser Models with PCM 555 or PCM 03	All Models

* Future software releases will include other models with digital processors.

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Situation

Mercury Marine has partnered with SPX Corporation to develop a PC-based system designed to aid the dealership technician by reducing the diagnostic times required to identify the root cause of electrical and electronic fuel controlled system problems. The software consists of a user friendly menu driven interface, engine data screens, step-by-step pinpoint guided diagnostics for certain models, internet connectivity for timely software updates, and integrated service manuals.

The basic Computer Diagnostic System (CDS) is offered in three different configurations. The first will consist of diagnostic software, SmartComms Interface Box, storage case Dell D500 laptop and Quick Setup Guide. The second configuration includes all of the items listed above and includes a "Rugged" Panasonic CF-18 laptop computer in place of the Dell D500 laptop. The third configuration is designed for our partners who have recently purchased a computer and do not wish to purchase another. The diagnostic software and SmartComms Interface Box is offered to those who have a computer that meets the minimum system requirements.

Optional kit accessories available include: an Electrical Harness Break-Out Box, Harness Pin Probes, 12 Volt DC Adapters, and the DMT 2004 VOM Meter with communications interface. Additionally, Mercury Precision Parts is developing an Electronic Dual Pressure Tester with communications interface. These communications interfaces will reduce required technician key strokes, remove entry errors and decrease troubleshooting times when using the pinpoint guided diagnostics.

Version in English is available; other languages will be supported in future releases.

The CDS system will use the same diagnostic harness assemblies as the DDT. Diagnostic harness assemblies are not included in the kit from SPX and must be ordered from Mercury Precision Parts. The diagnostic harness assemblies are listed at the end of the bulletin.

Minimum System Requirements

900 MHz Pentium Processor	PCMIA slot
USB port	256MB Ram
Windows 2000	DVD Drive
56K Modem	10 GB Hard Drive

Ordering Information

To get additional information, pricing or to order the Computer Diagnostic system contact:
SPX Corporation
28365 Mound Rd.
Warren, MI 48092

or call:

USA - 1-800-345-2233
Canada - 800-345-2233
Europe - 49 6182 959 149
Australia - (03) 9544-6222

Adapter Cable Harnesses

Mercury/Mariner Outboard and Jet Drive Adapter Harnesses

Harnesses are purchased from Mercury Precision Parts.

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NOTE: All harnesses are not used with current software revision level. Future software releases will use additional harnesses.

Description	Part Number
1994 3.0L Carb Engines	84-822560A 1
1994-1/2 and up 2.5L EFI (with 824003 ECM only) 1994-1/2 Pro Max/Super Max/Super Magnum 1997 and up DFI/OptiMax Outboards	84-822560A 5
1995 - 2001 3.0L EFI and Carb Outboards (Use with 84-822560A 7)	84-822560A 6
1995 - 2001 3.0L EFI and Carb Outboards (Use with 84-822560A 6)	84-822560A 7
All Hi-Performance 2.0L/2.5L EFI Outboards (with 11350A ECM only) (Use with 84-822560A 7)	84-822560A 8
25-40 hp 4-cycle Outboards. (Use with 84-822560A 7)	84-822560A10
Extension Harness, 2-pin 4.57 m (15 ft.) (Use with 84-822560A 5)	84-822560T11
2000 Digital OptiMax Outboards only. This T Harness allows the DDT to be connected under the dash at the 5-pin tachometer harness outlet.	84-875232T 1
For Verado 200-275 hp (adapts flat 4-pin connector to 2-pin 84-822560A5 harness).	84-822560T12
Verado 200-275 hp 4-Cycle Outboards (4-pin connectors, no additional harness required)	84-822560A13
225 EFI FourStroke. Not for use with the DDT.	84-822560A14
CAN 1 diagnostics cable. Connects into a junction box or male to male adapter cable for Command Module configuration. Not for use with the DDT.	84-892663
Male to male adapter cable. Allows connection between CAN 1 communications cable and Command Module harness in applications where a junction box is not used.	84-892452A01

Mercury/Mariner Outboard Injector Test Harnesses

Description	Part Number
1986 and up 2.4L/2.5L/3.0L EFI Outboards. (Use with 84-822560A 7) 1982 and up Hi-Performance 2.0L/2.4L/ 2.5L/3.4L EFI Outboards (Use with 84-830043A 2)	84-830043A 1
1982 and up Hi-Performance 2.0L/2.4L/2.5L/3.4L EFI Outboards (including Offshore models). (Use with 84-830043A 1)	84-830043A 2

MerCruiser Adapter Harnesses

Harnesses are purchased from Mercury Precision Parts.

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NOTE: *All harnesses are not used with current software revision level. Future software releases will use additional harnesses.*

Description	Part Number
For MEFI-1/-2/-3 ECM models	84-822560A 2
For PCM 555 models (adapts 4-pin MerCruiser connector to 2-pin Outboard harness)	84-822560T12 and 84-822560A 5
For PCM 555 models (4-pin connectors, no additional harness required)	84-822560A13
1997 and up V6 and V8 Carb Engines with Thunderbolt V Ignition. Allows RPM history stored in Ignition Module to be read. (Use with 84-822560A 7)	84-861540A 1
CAN 1 diagnostics cable. Connects into a junction box or male to male adapter cable for Command Module configuration. Not for use with the DDT.	84-892663
Male to male adapter cable. Allows connection between CAN 1 communications cable and Command Module harness in applications where a junction box is not used.	84-892452A01

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MerCruiser EFI Tool List

Fuel System Tools:

Fuel pressure gauge set	91-881833A2
Adaptor fitting set (MT337-300 Snap-On)	91-803135
Replacement seals for adapter fittings (Snap-On)	
GM test port seal (large)	8-4814
MC Schrater test port seal (small)	8-4914
O-ring	8-4614
TBI adaptor fitting (with tire-valve fitting)	91-806901
Fuel line adaptor (with nipple fitting)	91-18078
Fuel line shut-off tool	91-805918A2
MPI injector noid light (Bosch connector)	J-34730A2/OTC #7188
GM TBI injector noid light	J-34730-400/OTC #7187
Fuel line disconnect tool set	J37088-A/J-41769/OTC#7660
$^{3}/_{8}$" fuel supply at rail	J-37088-1A or J-41769-1
$^{5}/_{16}$" fuel return plug at rail	J-41769-2
Portable 6.6 gal. Fuel Tank[1]	See current “MPP Acessories Guide” for selection of tanks
Cole-Parmer Digital PSIG Gage[2]	Model No. 68920-10
Stevens Instruments Gearcase Pressure Tester[3]	S-34
Fuel quality testing kit	J-39383A/OTC#7670
Fluke Pressure/Vacuum Transducer Module	PV-350 (Fluke #)

Electrical System Tools:

DMT 2004 multi-meter Set (10 Mega-ohm impedance)		91-892647A01
Clamp-on ammeter probe (for any standard DVOM)		91-802650
DVA adaptor (for any standard DVOM)		91-89045-1
EFI 12v test light[4] (unpowered)		J-34142-B
IAC noid light	(Rinda #94016)	OTC #3053S
EFI test lead set		Rinda #94025
GM style harness test leads		J-35616-A
Packard connector repair Kit		J-38125-B
Quicksilver Electrical Hardware Kit (bullet connectors)		86-813937A2
Quicksilver Crimping Pliers (packard style)		91-808696
Quicksilver Harness Seal Kit		91-881814A1
Snap-on Terminal Tool Kit[5]		TT-600
Remote Starter Switch		91-52024A1

Ignition System Tools:

Kilo-Volt meter (Snap-On)	MT2700 DIS/KV
Air gap spark tester (single 1/2 inch gap)	91-63998A1
Air gap spark tester (8 adjustable gaps)	91-850439T1
Timing jumper plug (jumps A & B at DLC)	91-805747A2
Continuity light (1.5v self-powered)	J-21008-A
Timing light[6]	Locally available

General Diagnostic Tools:

Hand vacuum pump (Mity-Vac or equivalent)	J-23738-A/OTC #7059
Rinda CodeMate (winky-blinky)	94008
Rinda MerCruiser scan tool (current software version 4.0)	94050m
Software update for scan tool (version 4.0)	94056
ECM/PCM 555 adapter cable	64006
Update for scan tool (software and cable)	94056
Rinda Diacom PC software and cable (Windows Version)	94010m
Quicksilver DDT (digital diagnostic terminal)	91-823686A2
MerCruiser DDT cartridge (current software version 2.0)	91-803999
SmartCraft DDT cartridge (version 1.3)	91-880118-003
MerCruiser DDT adaptor cable (DLC and injector connectors) (MEFI ECM's)	84-822560A2
SmartCraft MerCruiser DDT adaptor cable (ECM/PCM 555 ECM's)	84-822560A13 or, 84-822560A5 and 84-822560T12
OTC replacement "boot" for DDT	OTC #3305-30
OTC printer for DDT	OTC #3285
OTC printer cable for DDT (25-pin serial port)	OTC #212536
OTC PC cable for DDT (9-pin serial port)	OTC #212535
Standard manifold vacuum gauge[7]	Locally available
Mechanics stethoscope[8]	Locally available
3" of 5/32" I.D. clear vinyl hose with a 5/32" Tee[9]	Locally available
5/16" or 3/8" clear vinyl hose with a hose barb on one end[10]	Locally available

Footnotes:

1. Used to provide source of known quality fuel or to bypass boat fuel system as required. Should be used only by trained Marine Technicians and only for short-term diagnostic purposes.
2. Used for both pressure and vacuum tests. "Gauge Guard" is not necessary. Reads from absolute zero to 199.9 PSI.
3. Can be used to apply slight pressure to test fuel systems for leaks.
4. Must have a minimum of 100 milliamps draw, but not more than 300 milliamps.
5. Contains six tools for removal of terminal pins from harness blocks
6. Such as the Ferret 80 series from Stevens Instruments, OTC and other suppliers.
7. Such as Snap-On MT14GS15SV
8. Used to listen to fuel injectors, air leaks, fuel pump(s) and IAC operation.
9. Used to check fuel pressure regulators for leakage and to attach vacuum gauge.
10. Used to check the VST vent line for the presence of raw fuel.

Tool Manufacturers

Cole_Parmer Instrument Co.
800-323-4340
847-549-7600
847-247-2929 FAX
847-549-1700 International FAX

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
773-736-6633
Fax: 773-736-2950

OTC Tools/SPX Corporation
655 Eisenhower Drive
Owatonna, Minnesota 55060
800-533-0492
Fax: 800-283-5665

Fluke Corp.
P.O. Box 9090
Everett, WA 98206-9090
800-443-5853

Kent-More Tools/SPX Corporation
(J-tools)
29784 Little Mack
Roseville, MI 48066
800-345-2233
Fax: 810-578-7375

Stevens Instruments
111 Greenwood Avenue
Waukegan, Illinois 60079-9375
847-336-9375
Fax: 847-662-6808

SPX Service Repair
2800 Park Drive
Owatonna, MN 55060
800-344-4013

SERVICE INFORMATION

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None as of print date.

MERCURY WHO-TO-CALL LIST

NOTE: '800' Numbers Cannot Be Transferred to Other Departments & Are for Dealer Use Only

Dealer Sales – Outboard, MerCruiser, Inflatable, MotorGuide

Phone	(800) 962-0927
Fax	(920) 929-5017

Dealer Sales Parts & Accessories

Parts Assistance	(800) 487-6372
Fax Ordering	(800) 457-8736
Obsolete Parts Locator	(800) 558-6300

Government Sales

Engine and Parts Sales	(888) 550-6372

Mercury Hi-Performance

Sales & Marketing	(920) 921-5330
Sales & Marketing Fax	(920) 921-6533
Dealer Technical Service/ Warranty Pre-Authorization	(920) 924-2088
Technical Service QuickFax	(920) 924-2096

Product Registration Inquiry

Outboard, MerCruiser, MotorGuide	(920) 929-5054

Warranty Claim / Credit Information

Outboard & MotorGuide	Phone	(920) 929-5054
	Fax	(920) 929-5893
MerCruiser	Phone	(405) 743-6539
	Fax	(405) 743-6548

Product Protection

Dealer Line	(866) 521-2024
Consumer Line	(888) 427-5373
Fax	(920) 926-2255

Dealer – Technical Service

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Inflatables Fax	(800) 926-7013
MerCruiser	(405) 743-6555
MerCruiser Quick Fax	(800) 245-8794

MercNET / MIDAS

Customer Service	(800) 556-4327
Fax	(920) 924-1042

Mercury University

Sales / Management Courses	(888) 326-3728
Service Courses	(920) 929-5220
Fax	(920) 929-5929

Service Publications

Ordering / Information	(920) 929-5110
Fax	(920) 929-4894

Quicksilver Generator Sales & Service

Generac Corporation P.O. Box 8 Waukesha, WI 53187	(800) 526-2871

CONSUMER ONLY PHONE NUMBERS:

Outboard & MotorGuide	(920) 929-5040
MerCruiser	(405) 743-6566
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